UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX A

CORRESPONDENCE

Appendix A
Correspondence

1. Letter dated June 26, 2017, from the District to resource agencies and initiating NEPA coordination and requesting information from consulting parties

2. Letter dated July 21, 2017, from the USFWS in response to the District's letter dated June 26, 2017, providing information regarding environmental resources in the Project area, including federally-protected species

3. Report from Scott Gritters, Fisheries Biologist, IADNR, and Dan Kelner, USACE, providing mussel data gathered during the August 2, 2017, shoreline survey of Steamboat Slough

4. Memorandum dated August 31, 2017, from the MVD Director of Programs to the Rock Island District Commander approving the Review Plan for the Steamboat Island HREP

5. Public Review After Action Report documenting the open house held March 26, 2018, and the comments received from the public

6. Email dated May 18, 2018, from Seth Moore, Environmental Specialist, IADNR, to the Rock Island District providing information regarding environmental resources in the Project area, including Federal and state-protected species

7. Memorandum dated May 22, 2018, from the MVD Director of Programs to the Rock Island District Commander approving the revised Steamboat Island HREP fact sheets and enclosures

8. Final Report dated November 9, 2018, from Ecological Solutions and Innovations, Inc., providing results of mussel survey conducted in the Project area to aid in refining Project measures

9. Conference call dated November 15, 2018, with the USACE, the USFWS, IADNR, and ILDNR, recounting discussion of the November 9, 2018, mussel survey results, working through each Project measure to determine potential impacts, and identifying areas requiring further survey

10. Email dated November 20, 2018, from the USFWS in response to the District's request for environmental input to the Feasibility Study

11. Email dated December 4, 2018, from the USFWS and IL DNR providing Steamboat Island HREP mussel considerations for Federal and state-listed endangered and threatened species

12. Final Report dated January 24, 2019, from Ecological Solutions and Innovations, Inc., providing results of mussel survey conducted in the Cordova EHA used to assess habitat suitability in the HREP Mussel Model

13. Meeting Read Ahead package for PDT meeting on February 7, 2019, describing the Project's aquatic and topographic diversity sites to the PDT for discussion and refinement at a general TSP refinement meeting

14. Email dated April 9, 2019, from Sara Schmuecker, USFWS, regarding an April 4, 2019, meeting with the Corps, USFWS, and IADNR to discuss the scope of the 2019 mussel survey and concurrence that no bat or eastern massasauga rattlesnake surveys are required

15. Memorandum for Record dated June 6, 2019, recounting the In-Progress Review meeting with MVD on April 11, 2019

16. Survey report of mussel data gathered during the 2016 surveys of the Steamboat Slough and the Cordova mussel beds provided by email from Jeremiah Hass, Fisheries Biologist, QC Generating Station.

17. Memorandum for Record dated September 13, 2019, recounting discussions with the IADNR on September 12, 2019, to provide guidance and a path forward regarding floodplain permitting for the Project

18. Memorandum for Record dated October 3, 2019, from Rachel Perrine, USACE, documenting the floodplain permitting coordination with IADNR and determination that the Project does not require a floodplain permit from the State of Iowa

19. Meeting Read Ahead package for PDT meeting on November 7, 2019, describing the results of the mussel survey conducted in August 2019 to the PDT for discussion

20. Email from Davi Michl, USACE, recounting phone conversation with the USFWS on December 19, 2019, documenting the USFWS determination that a Biological Assessment is not warranted based on the 2019 mussel survey results and informal consultation can be concluded by letter with effects determination

21. Letter dated December 20, 2019, from the Rock Island District to Illinois and Iowa SHPOs and cultural groups describing the proposed Project, historical properties in the Project area, and the need for a Programmatic Agreement to ensure Section 106 compliance

22. Letter dated January 8, 2020, from the Illinois SHPO providing evidence of Section 106 compliance and no objection to the Project

23. Letter dated January 22, 2020, from the Rock Island District to the USFWS requesting concurrence with determinations made by the District regarding federally-endangered or threatened species listed under the Endangered Species Act and requesting concurrence to conclude informal consultation

24. Letter dated February 21, 2020, from the USFWS to the Rock Island District providing concurrence with determinations made by the District regarding federally-endangered or threatened species listed under the Endangered Species Act and concluding informal consultation

25. Letter dated April 3, 2020, providing the Draft Fish and Wildlife Coordination Act Report from Kraig McPeek, U.S. Fish and Wildlife Service

26. Letter of Support dated April 8, 2020 from Sabrina Chandler, Refuge Manager, Upper Mississippi River National Wildlife and Fish Refuge, regarding the Steamboat Island HREP and value of the Project

27. Letter of Support dated April 9, 2020, from Kayla Lyon, Director, Iowa DNR, regarding the Steamboat Island HREP and value of the Project.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS - ROCK ISLAND DISTRICT
CLOCK TOWER BUILDING - PO BOX 2004
ROCK ISLAND ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

June 26, 2017

Regional Planning and Environmental
Division North (RPEDN)

SEE DISTRIBUTION LIST

The U.S. Army Corps of Engineers, Rock Island District (District), is currently planning an Upper Mississippi River Restoration Program (UMRR), Habitat Rehabilitation and Enhancement Project (HREP) for Steamboat Island, Mississippi River. The proposed Project is located in Pool 14 between the Wapsipinicon River (River Mile 506.5) and the town of Princeton (RM 502.5) in Scott County, Iowa (Encl. 1). Authority for this Project was provided in the Water Resources Development Act of 1986, Section 1103. The Project sponsor is the U.S. Fish and Wildlife Service.

Habitat quality on Steamboat Island and an adjacent secondary channel complex is degraded by channel and backwater sedimentation, water level fluctuations, forest and wetland degradation, and invasive species encroachment. Habitat degradation results in reduced habitat quality for forest, wetland, backwater, and riverine species. The objective of the Project will be to preserve and restore natural habitat diversity using measures such as: increasing backwater depth, maintaining aquatic connectivity, protecting wetlands, conducting timber stand improvement, increasing topographic diversity, and forest plantings.

The District proposes to study various restoration alternatives and their efficiency in meeting the Project's objectives. Restoration measures may include various backwater dredging techniques (e.g., hydraulic, mechanical); hardwood timber stand improvement (e.g., berm, planting, selective thinning); hydrological connection (e.g., water control structures, dredged channels, rock structures, etc.); or any combination thereof. Dredging will increase bathymetric and topographic diversity as backwaters are deepened and terrestrial areas are raised with dredged material. Maintaining and improving hydraulic connectivity helps manage side channel, backwater, and wetland habitat to provide fish access to spawning, feeding, and overwintering habitats.

The District plans to prepare National Environmental Policy Act (NEPA) documentation for this Project. At that time, we will identify any existing significant resources or other environmental concerns associated with the proposed Project such as wetlands; state- or federally-listed threatened/endangered species; prime and unique farmlands; land use plans; or floodplain/floodway issues. Additionally, as part of the NEPA alternative analysis, the District will evaluate the Project's habitat benefits. We will be forming a Habitat Evaluation Procedures (HEP) team to determine the habitat benefits associated with various alternatives. Stakeholder input and participation on this team is welcomed and strongly encouraged.

The District requests your comments on this Project with respect to concerns for or anticipated effects on any resources within your agency's jurisdictional oversight. Any reports, studies, or other research concerning environmental resources in the Project vicinity are also valuable. Please provide your comments within 30 days of the date of this letter.

If you have any questions or would like to participate during the HEP analysis, please contact Dr. Charles Theiling of our Environmental Planning Branch, [redacted] email: charles.h.theiling@usace.army.mil, or by writing to our address, ATTN Regional Planning and Environmental Division North (Chuck Theiling).

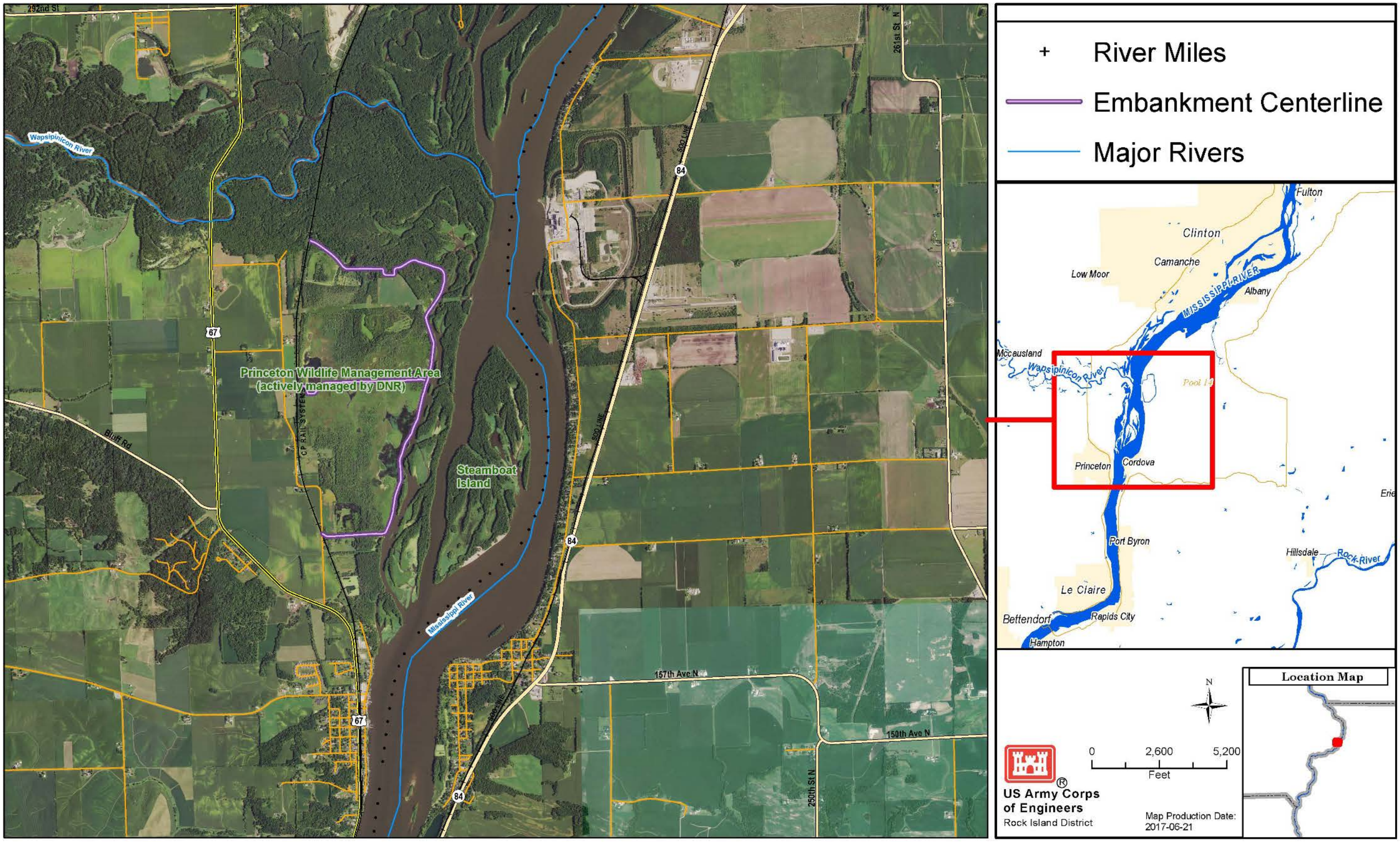
Sincerely,

Jodi K Creswell

Jodi K. Creswell
Chief, Environmental Planning Branch (RPEDN)

Encl
(as)

Enclosure 1: Steamboat Island HREP Site Map



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United States Department of the Interior

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IN REPLY REFER TO:

FWS/IIFO

July 21, 2017

Jodi Creswell
Chief, Environmental Planning Branch
Attn: Charles Theiling
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61201-2004

Dear Ms. Creswell:

Thank you for the opportunity to review the proposed Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP). The Steamboat Island HREP is located in Pool 14 of the Mississippi River, between the town of Princeton (River Mile 502.5) and the Wapsipinicon River (River Mile 506.5), in Scott County, Iowa. Per your letter of June 26, 2017, the Corps proposes to study the following habitat restoration alternatives for potential implementation at the Steamboat HREP site: backwater dredging, hardwood timber stand improvement (e.g. berm, planting, selective thinning), and hydrological connection (e.g., water control structures, dredged channels, rock structures, etc.). We have reviewed your letter and have the following comments.
Section 7 of the Endangered Species Act of 1973 requires that actions authorized, funded, or carried out by Federal agencies not jeopardize federally threatened or endangered species or adversely modify designated critical habitat. To fulfill this mandate, Federal agencies (or their designated non-federal representative) must consult with the Service if they determine their project "may affect" listed species or critical habitat.

In order for you to evaluate the potential effects of your project on federally listed species, you can download a list of species listed for Scott County from the Service's Region 3 Technical Assistance website at http://www.fws.gov/midwest/endangered/section7/sppranges/index.html. Habitat descriptions for these species can also be found on our website. You may use these descriptions to help you determine if there is suitable habitat within the project area. If no suitable habitat exists within the project area or its area of impact, and no species or critical habitat is present, it is appropriate to determine the project will have "no effect" on listed species. If you determine the action will have "no effect" on listed species or critical habitat, concurrence with that determination from the Service is not required. Concurrence for "no effect" determinations will not be provided by the Illinois-Iowa Ecological Services Field "Office for projects in Illinois or Iowa due to reductions in staff. We recommend you maintain a written record of why a "no effect" finding is warranted and include it in your administrative record. An example of a "no effect" memo can be found on our website at http://www.fws.gov/midwest/endangered/section7/s7process/letters.html.

If suitable habitat is found in the area of your project, the appropriate determination is that the project "may affect" listed species. In some instances surveys may be recommended to help make this determination. Additional information on how to make accurate effect determinations and how to document your determination can be found on our website at http://www.fws.gov/midwest/endangered/section7/s7process/step1.html.

Additionally, the Service removed bald eagles (*Haliaeetus leucocephalus*) from protection under the ESA on August 8, 2007. However, they remain protected today under the MBTA and the Eagle Act. The Eagle Act prohibits take which is defined as, "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb" (50 CFR 22.3). Disturb is defined in regulations as, "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior."

In particular, the proposed project actions, as described in your letter of June 26, 2017, have the potential to impact federally protected migratory tree bat, migratory bird, eagle, and freshwater mussel resources.

<u>Migratory Tree Bats</u>

Summer habitat for the federally endangered Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*) includes roosts under loose tree bark on dead or dying trees and foraging within or along the edges of forested areas. The proposed project includes the removal and/or alteration of forested habitat that has the potential to provide summer roosting and foraging habitat for these bat species. Should impacts to forested areas be planned, we recommend a survey be conducted to identify Indiana and northern long-eared bat roost trees. Identified roost trees should not be felled, tree clearing should not result in habitat fragmentation, and we recommend all tree clearing be conducted outside of the maternity season of April 1 through September 30. Please note, certain incidental take resulting from tree removal is identified in the final 4(d) Rule for the northern long-eared bat (50 CFR 17) as exempted from prohibition under the Endangered Species Act.

<u>Migratory Birds and Eagles</u>

The forested habitat on Steamboat Island has the potential to provided nesting habitat to several species of migratory birds. We recommend that any proposed removal and/or alteration of forested habitat be conducted prior to spring nesting to reduce potential impacts during the nesting season.

Bald eagles winter along the Mississippi River, including Pool 14. Suitable perch trees where eagles can loaf and perch are numerous, including the forested areas of Steamboat Island. One bald eagle nest site is known to occur on the head of Steamboat Island. This nest was observed to be active in 2017. All construction activities should be restricted within 660 feet of any identified active eagle nest to outside the nesting season.

Freshwater Mussels

A significant mussel resource has historically been documented throughout Pool 14, particularly within the vicinity of Steamboat Island. Mussel surveys along the right and left descending banklines of Steamboat Island have identified upwards of 21 freshwater mussel species, as recently as 2012, including the federally endangered Higgin's eye pearlymussel *(Lampsilis higginsii)* and several State of Iowa listed species. Additionally, the project is within range of the federally endangered sheepnose mussel (*Plethobasus cyphyus*) and the spectaclecase mussel (*Cumberlandia monodonta*). Proposed project construction activities including installation of water control structures, dredging, and placement of rock structures have the potential to disrupt or alter freshwater mussel habitat. Should impacts to potentially suitable mussel habitat be identified, we recommend a freshwater mussel survey be conducted.

These comments provide technical assistance only and do not constitute the report of the Secretary of the Interior on the project within the meaning of Section 2(b) of the Fish and Wildlife Coordination Act, do not fulfill the requirements under Section 7 of the Endangered Species Act, nor do they represent the review comments of the U.S. Department of the Interior on any forthcoming environmental statement.

Thank you for the coordination of this project and for the opportunity to provide comments. If you have any questions regarding these comments, please contact [redacted] of my staff at ([redacted] or [redacted].gov.

Sincerely,

Kraig McPeek
Field Office Supervisor

S:\Office Users\Sara\UMRR Program\HREPs\Steamboat\2017 07-19 Steamboat Island HREP TE Letter

Shoreline mussel survey of Pool 14, Steamboat Slough side channel, at River Mile 505 Conducted by Scott Gritters- Iowa Department of Natural Resources and Dan Kelner U.S. Army Corps of Engineers.

Methods

Trained malacologists from the Corps of Engineers, US Fish and Wildlife Service and Iowa DNR conducted five timed freshwater mussels' searches (pollywogging) of Steamboat Slough on August 2nd, 2017 (Figure 1). The survey teams searched shallow shoreline areas on both the right and left descending bank. Five qualitative searches totaling 440 minutes of search time were recorded. Sampling locations are shown in Figure 1.

On August 2nd, the Pool 14 surface elevation recorded at the USGS gauge 05420500 in the Mississippi River at Clinton, IA was 11.2 feet and the flow was 51,600 cubic feet per second. Water temperature was 27.2 degrees Celsius. Substrate of all five sites surveyed was predominately mud with some sand and some evidence of zebra mussel shells. The high mud content may be due to the recent flooding of the Wapsipinicon River which is just upstream of the survey site. In most areas nearly a foot of "new" sediment covered most of the river bottom. Survey depth to allow shoreline searching (non-divers) was generally less than one meter and was a limited habitat as most of the slough depth is over one meter. This survey represents most of the shallow near shore habitat that exists in Steamboat Slough. If additional mussel surveys are warranted they will need to be conducted by dive teams in the deeper water.

Findings

The 440 minutes of timed searches yielded 11 mussel species. By this richness metric the Iowa DNR would classify this site as fair to poor compared to other Mississippi River mussel beds. The mean catch rate which could be calculated combined for sites two and five and was 0.16 mussels per minute or 8 mussels per hour. This catch rate would be considered poor compared to other Mississippi River mussel beds. Catch rate of mussels seemed to decrease northward in the slough. The upper most sampling site (Site 5) was nearly devoid of mussels but appeared to have similar habitat to the other sites surveyed. Most of the mussel species surveyed are considered "tolerant" species, and able to survive in poorer habitat reaches of the Mississippi River.

The collection of 21 Yellow Sandshells (*Lampsilis teres)* was a significant finding in this survey. The Yellow Sandshell is considered an Iowa state endangered species but apparently has made a recent comeback in this reach of Mississippi River. Yellow sandshell have been found in recent surveys of Pool 14 and neighboring Pools. All Yellow Sandshell specimens found in this survey were found at the lower three sites (Sites 1-3).

Conclusion

Limited habitat exists for shoreline searches in Steamboat Slough and much of the habitat available was sampled during this effort. Shoreline habitat in Steamboat Slough generally consisted of mud and sand. The mussels that exist along the shorelines of Steamboat Slough are generally common tolerant species and density and richness appears to be somewhat low. If additional surveys of the Slough are warranted they will need to be conducted by diving teams in deeper water.

Figure 1. Locations of timed mussel searches in Steamboat Slough on August 2nd, 2017.

Table 1. Mussel species found in Pool 14, Steamboat Slough wadding Survey on August 2nd, 2017

Scientific name	Common Name	Site 1	Site 2	Site 3	Site 4	Site 5	**Totals**
Amblema plicata	three ridge	X	23	X	X		**X**
Fusconaia flava	wabash pigtoe	X		X	X		**X**
Lampsilis cardium	plain pocketbook	X		X	X		**X**
Lampsilis teres	yellow sandshell	3	5	13			**21**
Leptodea fragilis	fragil papershell			X	X		**X**
Obliquaria reflexa	three horn wartyback	X	5	X	X	1	**X**
Potamilus alatus	pink heelsplitter			X			**X**
Potamilus ohiensis	pink papershell		2				**2**
Pyganodon grandis	giant floater		2	X	X		**X**
Quadrula pustulosa	pimpleback		1		X		**X**
Toxolasma parvus	liliput	X		X			**X**
Total			38			1	
Number of Species		6	6	9	7	1	**11**
Time Searched (min)		60	180	70	70	60	**440**
UTM Easting		722152	722194	722330	722586	722749	
UTM Northing		4618998	4619250	4619599	4620295	4621104	
X= species found live							

DEPARTMENT OF THE ARMY
MISSISSIPPI VALLEY DIVISION, CORPS OF ENGINEERS
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080

REPLY TO
ATTENTION OF:

CEMVD-DE

31 AUG '17

MEMORANDUM FOR Commander, Rock Island District

SUBJECT: Review Plan Approval for the Upper Mississippi River Restoration (UMRR) Habitat Rehabilitation Enhancement Project, Steamboat Island

1. References:

a. Memorandum, CEMVR-PD-F, 6 July 2017, subject: Upper Mississippi River Restoration (UMRR) Habitat Rehabilitation Enhancement Project, Steamboat Island Review Plan (RP) (encl 1).

b. Memorandum, CEMVD-RB-T, 21 August 2017, subject as above (encl 2).

c. Memorandum, CECW-MVD, 16 May 2012, subject: Request for Approval of a Model Peer Review Plan for the Upper Mississippi River System Environmental Management Program (encl 3).

d. EC 1165-2-214, 15 December 2012, subject: Civil Works Review Policy.

2. The enclosed Review Plan (RP) (encl 4) is a combined decision document and implementation document review plan. It includes the MVD EMP checklist and has been prepared in accordance with EC 1165-2-214. The RP has been coordinated between the Business Technical Division and the Upper District Support Team.

3. I hereby approve this RP, which is subject to change as circumstances require, consistent with study development under the Project Management Business Process. Subsequent revisions to this RP or its execution will require new written approval from this office. Non-substantive changes to this RP do not require further approval. The district should post the approved RP to its website.

CEMVD-DE
SUBJECT: Review Plan Approval for the Upper Mississippi River Restoration (UMRR) Habitat Rehabilitation Enhancement Project, Steamboat Island

4. The MVD point of contact is Mr. Gabe Harris, CEMVD-PDM, [redacted]

4 Encls

MICHAEL C. WEHR
Major General, USA
Commanding

STEAMBOAT ISLAND
Upper Mississippi River Restoration (UMRR)
Habitat Rehabilitation and Enhancement Project (HREP)
AFTER ACTION REPORT

1. Introduction. This document serves as the after-action report for the Steamboat Island HREP (Project) Public Open House held on March 26, 2018. At the public meeting US Army Corps of Engineers (USACE), US Fish and Wildlife Service (USFWS), and Iowa Department of Natural Resource (IADNR) representatives were available to discuss the existing and historic conditions at Steamboat Island and surrounding area, the preliminary problems, goals, and objectives developed by the team, and potential Project features brainstormed by the team, as well as gather comments and other pertinent feedback from the public. A short formal presentation was held at the beginning of the Open House.

2. Open House Objective. The objective of the Open House was to give a short presentation addressing the initiation of the HREP Feasibility Study and answer questions and listen to comments from the public.

3. Open House Location. The Open House was held at the Mississippi River Eco-Tourism Center in Rock Creek Park, 3942 291st Street, Camanche, IA.

4. Medium. A post card announcement was mailed to 330 addressees including congressional interests, federal, state and local governmental agencies; businesses, environmental organizations, media and the general public inviting them to attend an open house. The Corporate Communications Office also sent a news release to area television and radio stations and newspapers. Three radio and newspaper interviews were conducted prior to the Open House. USFWS Upper Mississippi River National Wildlife and Fish Refuge (UMR NWFR) also posted the Project and Open House information on their website.

5. Open House Format.

a. Date/Time: The open house was held on March 26, 2018 from 4:00 pm – 6:00 pm.

b. Staff: The Steamboat Island UMRR/HREP is a joint effort with the following agencies: USACE-Rock Island and St. Paul Districts, the USFWS, and the IADNR. The Corps/agency technical experts were present to talk one-to-one with the attendees during the Open House and to answer any questions. The representatives were:

Rachel Perrine – USACE-St. Paul District
Julie Millhollin – USACE-Rock Island District
Marshall Plumley – USACE-Rock Island District
Kathryn Herzog – USACE- St. Paul District
Cynthia Peterson – USACE- St. Paul District
Kyle Nerad – USACE-Rock Island District
Steve Gustafson – USACE-Rock Island District

Jessica Steslow – USACE-Rock Island District
Kara Mitvalsky – USACE-Rock Island District
Lucie Sawyer – USACE-Rock Island District
Sam Heilig – USACE-Rock Island District
Ben Vandermyde – USACE-Rock Island District
Mike Griffin – IADNR
Kirk Hansen – IADNR
Scott Gritters – IADNR
Sara Schmuecker – USFWS, Illinois-Iowa Field Office
Tyler Porter – USFWS, Illinois-Iowa Field Office
Sharonne Baylor – USFWS, UMR NWFR
Ed Britton – USFWS, UMR NWFR-Savanna District
Russ Engelke – USFWS, UMR NWFR-Savanna District

c. Information and Displays. Each guest received a folder that contained UMRR information, the Open House Comment Card, a 2-page Project summary, and a copy of the Project's "Considerations and Constraints" map. A synchronized presentation was developed for the short formal presentation, which was well received by the audience. Three Subject Matter Expert (SME) stations were set up in the room: Engineering, Environmental, and Programs/Planning. Each SME had "Project Overview" and "Potential Project Features" (poster-size) maps. A presentation showing examples of potential Project features was developed and displayed after the formal presentation on the main screen and at the Engineering SME station. The Engineering SME also displayed a large map showing the bathymetric LiDAR data collected in 2018 and had copies (CD and hard copy) of the UMRR Design Handbook available. The Environmental SME also had a poster-size map of the Project's "Considerations and Constraints" on display. The Programs/Planning SME had copies of the Feasibility Report schedule, 6-step planning process, and copies of the 2016 Report to Congress. USFWS provided information about the UMR NWFR and Federally-listed species profiles. There was an area near the SME stations that had large Project overview maps that the public could mark on and indicate areas of interest or feature ideas.

d. Social Media: The Corporate Communications Office streamed the Open House live on Facebook. At one time during the meeting, 19 people were watching the live feed. During the meeting there were 7 comments from the public and the team fielded 3 questions from the online comments. During and after the event, the Facebook live video was shared 14 times, reached 2,815 people and was viewed 1,167 times. Prior to the Open House, an event was created on Facebook by the Corporate Communications office and was shared to partnering agencies. This event reached more than 18,000 people in 12 days and garnered 113 responses from Facebook users. An article about the Open House published by a local newspaper was also shared by the Corporate Communications office on Facebook and it was shared 9 times and reached an additional 2,484 people.

6. Attendance. There were approximately 75 people in attendance. The attendees were asked to complete a comment sheet. Results of the returned comments are shown in paragraph 7 below.

7. Public Comments. Attendees were asked to fill out a comment sheet. A total of 3 sheets were submitted.

a. All surveyed participants ‘completely agreed’ that the Open House gave them an opportunity to better understand the Project and provided an opportunity to offer comments and feedback to the Project team.

b. Participants also appreciated the opportunity to talk with technical experts during the Open House.

c. Comment Card statements:
   - Improve Beaver Island back to fisheries and hunting and areas around the Island.
   - Keep public appraised of the project.
   - A significant resource at the Project area is the opportunity for the public to get closer to a natural setting while remaining close to home.
   - If you expand the beach area for boaters first, this will generate a very favorable public opinion. Boaters spend money and this helps the local economy.
   - Shallow water at the beach is preferred by today’s boaters and a larger shallow beach area is needed to accommodate the volume of boaters.
   - Steamboat Slough should be opened back up to make it a good “off channel” water sports area.
   - More recreational usage at “Princeton Beach” will increase the conflict between barge traffic and recreational and water sports boaters. As part of this project, steps need to be taken to reduce this danger.
   - Barges loaded with toxic chemicals tie up for days on the north end of Steamboat Island across the river from Hugunins light at 504.6L. In line with the ECO theme of this project this practice should be prohibited.

d. Questions/Features ideas from guests (discussions between public and technical experts):
   - Can we dredge and do aquatic diversity in the forested area south of the Wapsipinicon River?
   - Can we incorporate a better connection between the Project and Princeton WMA (pumping, etc)?
   - How often will we dredge to address future sedimentation?
   - Can we deal with the sand that comes off “Princeton Beach” and silts in downstream?
   - How will the team prioritize dredging areas?

e. Additional comments (discussions between public and technical experts):
    - There was a lot of positive feedback about the Open House and Project. The guests expressed satisfaction in the UMRR Program and that we are pursuing restoration efforts at Steamboat Island and surrounding area.
    - The Engineering SME received positive feedback about the new technology being used to collect LiDAR data.
    - Ben, Project Forester, received positive feedback about the process and potential ideas for forestry improvement – many were excited about hickory plantings.
    - Many guests have maps/photos to share and are interested in volunteer efforts during Project construction/planting. We will have to look into how to use volunteers for construction and implementation.
    - A guest reported that a Professor Danforth used to take a houseboat to the Project area and do bug/bird/etc counts. We may be able to find and use that information.
    - A guest reported that there are sites within the Project area that contain purple turtlehead flowers.
    - A guest was concerned that the wing dam would be left out of the project. The wing dam had a large opening (150 feet) and it was about 10 feet deep, but now you can't get through with a canoe. The wing dam is in the "cut off" area. He would like the wing dam fixed and noted that he used to run his houseboat over it.

8. **Team Comments.** Members of the USFWS, IADNR, and USACE-Rock Island District also provided feedback on the event.

    a. Set up of the room (presentation area with sitting in center and SME stations around the back wall of the room) provided a good layout for people to ask questions to the right project team member.

    b. The facility was great and provided adequate room for public participation.

    c. Facebook Live worked well and provided a forum for commenting for the people who were unable to attend.

    d. The team discussed having one map for public mark-up vs. a map at each SME station. There are pros and cons to each way.

8. Summary. The Open House was successfully executed and provided the public with a good forum to provide comments for the Project and initiation of the Feasibility Study. The discussion between the study team personal and the public was informative. Attendees generally support the open house format and the Project.

Rachel Perrine, CEMVP-RPEDN-PD-F, 26 April 2018

From: Moore, Seth
To: [redacted]
Subject: [Non-DoD Source] Re: Steamboat HREP
Date: Friday, May 18, 2018 10:07:56 AM

Kathryn,

Here are some comments from staff about the HREP.

Staff Botanist/Ecologist John Pearson:

The only Iowa location of state-Endangered Black-footed Quillwort (Isoetes melanopoda) was last reported in wetland habitat at the mouth of the Wapsipinicon River. A survey for this rare aquatic plant species would be very useful for its conservation.

Another state-listed species in the project area, Pink Turtlehead (Chelone obliqua) Special Concern was recently discovery in vicinity of Shaff Lake and the Mississippi River Ecotourism Center. I recommend survey for these two species in suitable habitat throughout the project area.

Staff Endangered Species Coordinator, Kelly Poole:

Indiana Bat and Northern Long Eared Bat guidelines would apply if tree removal occurs. In addition tree removal could impact the state-Endangered red-shoulder hawk (Buteo lineatus) which is known to nest in upper 1/3 of the project area but has potential in suitable habitat through out.

If you have questions concerning these comments, please let me know.

Thank you,

<Blockedhttps://lh3.googleusercontent.com/clNml9Dd11ZnuRCvocaNZN2LQyBwmHlVvCXEzxfFxwaA6VXV9Fpm_a0H6V7BV05fPDKnc58ZijV0f7IQXpplWKbs42MOinZ7I050QR3y43ttZrCAOzkmdJMVTVKi6ByQ4897OwFd>

Seth Moore | Environmental Specialist

Iowa Department of Natural Resources

[redacted]

Blockedwww.iowadnr.gov <Blockedhttp://www.iowadnr.gov/>

On Mon, May 14, 2018 at 7:12 AM, Herzog, Kathryn M [redacted] > wrote:

Good morning Seth,

In response to your email to Julie concerning Steamboat HREP, we are working closely with Kirk Hansen of IA DNR (cc'd). If you want to send me any specific information, please feel free to do so. We are working on existing conditions and any information you want to provide could be incorporated. An informal email will work.

Thanks,
Kat Herzog

[redacted]
United States Army Corps of Engineers
Environmental Planning Section
St. Paul District at Rock Island
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, MISSISSIPPI VALLEY DIVISION
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080

CEMVD-PDM

MEMORANDUM FOR Commander, Rock Island District

SUBJECT: Revised Factsheet Approval - Upper Mississippi River Restoration Program, Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa

1. References:

a. Memorandum, CEMVR-PM-M, 2 March 2018, subject: Upper Mississippi River Restoration Program, Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa, Revised Fact Sheet (encl 1).

b. Memorandum, CEMVD-PD-SP, 29 September 2010, subject: Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP), Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa, Fact Sheet (encl 2).

2. Subject Fact Sheet is approved for continued HREP planning (encl 3).

3. The MVD point of contact for this action is Mr. Gabe Harris, CEMVD-PDM, ([redacted]

3 Encls

GARY L. YOUNG
Chief, Planning Division

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
PO BOX 2004 CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

MAR 02 2018

CEMVR-PM-M

MEMORANDUM FOR Commander, US Army Corps of Engineers, Mississippi Valley Division (CEMVD-PD-SP/Harris), PO Box 80, 1400 Walnut Street, Vicksburg, Mississippi 39181-0080

SUBJECT: Upper Mississippi River Restoration Program, Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa, Revised Fact Sheet

1. The subject Fact Sheet (Encl 1) is submitted for your review and approval. An electronic copy has been sent to Mr. William Harris, CEMVD-PD-SP.

2. The original Steamboat Island HREP Fact Sheet was approved on 29 September 2010 (Encl 2).

3. The project area has expanded from 500 acres to about 2,600 acres. The area in the revised Fact sheet includes Steamboat Island, Steamboat Slough, and adjacent secondary channel complex (Grant Slough), smaller island southeast of Steamboat Island and the forested areas south and north of the Wapsipinicon River. The additional project area will protect, enhance, and restore aerial coverage and diversity of floodplain forest habitat and increase hard mast-producing trees.

4. Questions concerning this document should be addressed to Ms. Julie Millhollin, Project Manager, [redacted] or e-mail: [redacted].

Encls
as

CRAIG S. BAUMGARTNER
COL, EN
Commanding

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT (HREP)
SCOTT COUNTY, IOWA,
UPPER MISSISSIPPI RIVER RESTORATION-ENVIRONMENTAL MANAGEMENT PROGRAM
ROCK ISLAND DISTRICT

FACT SHEET
Revised

I. LOCATION

The Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) is located in Scott County, Iowa, in the middle of Pool 14 along the right descending bank of the Upper Mississippi River (UMR). Steamboat Island HREP lies between the town of Princeton (UMR River Mile 502.5) and the Wapsipinicon River (UMR RM 506.5), within the UMR National Wildlife and Fish Refuge. Areas considered as part of this Project and described as the Project area include Steamboat Island, Steamboat Slough, an adjacent secondary channel complex (Grant Slough), smaller islands southeast of Steamboat Island, and the forested areas south and north of the Wapsipinicon River (Figure 1). The Princeton State Wildlife Area is just west of the island.

II. EXISTING RESOURCES

The Project area includes interconnected backwaters, wetlands, islands, floodplain habitat, backwater lakes, sloughs, and flowing channels. Though degraded, this important backwater area supports a diverse population of wildlife including ducks, geese, swans, pelicans, eagles, and muskrats. Figure 2 shows 2000 and 2010 land cover data for the Project area.

Figure 1. General Project Location

III. PROBLEM IDENTIFICATION

Historically, Steamboat Island contained a number of small backwater lakes, sloughs, cuts, and flowing side channels. Similar habitats were found in the Grant Slough complex as well. These habitats provided valuable overwintering, spawning, and feeding areas for a variety of fish, especially centrarchids. Migratory birds, including waterfowl, shorebirds, and wading birds also used the area extensively.

Years of silt deposition has allowed willows and silver maples to colonize the once-aquatic portions of the Project area, resulting in a degraded aquatic and wetland complexes. In addition, impoundment of the pool and permanently higher water tables have affected the health of floodplain habitat on islands and adjacent floodplain areas. These higher water tables are affecting forest composition and regeneration.

IV. PROJECT GOALS AND OBJECTIVES

Project goals are derived from the Environmental Pool Plans, Pools 11 through 22; the Habitat Needs Assessment; and Reach Planning efforts. These project goals are consistent with the systemic goals adopted by the Environmental Management Program, now referred to as the Upper Mississippi River Restoration Coordinating Committee and the Navigation Environmental Coordination Committee in January of 2008.

Maintain, Enhance and Restore Quality Habitat for all Native and Desirable Plant, Animal and Fish Species

- protect, enhance, and restore aquatic habitat for viable populations of fish, invertebrates, aquatic and semi-aquatic mammals, reptiles, amphibians, waterfowl, shorebirds, etc.
- protect, enhance, and restore floodplain habitat for viable populations of the variety of mammals, birds, reptiles, amphibians, etc.
- protect, enhance, and restore aerial coverage and diversity of floodplain forest habitat and increase hard mast-producing trees

Maintain, Enhance, Restore, and Emulate Natural River Processes, Structures and Functions for a Sustainable Ecosystem

- stabilize flows throughout the complex
- restore sediment transport and deposition throughout the complex to a more "natural" condition
- minimize adverse effects of elevated water table on soil moisture conditions

V. PROPOSED PROJECT FEATURES

The proposed project includes backwater dredging to provide critical overwintering habitat for fish such as bass, crappie, yellow perch, and bluegill. The increase in wetland diversity would restore feeding habitat for resident and migratory birds. Dredged material could be used to create topographic diversity on the islands, to provide sediment control, or to maintain, create, or enhance nearby islands. Forest diversity could be accomplished by elevating islands, planting hardwoods, and forest management (Figure 3).

The above-proposed features will protect, enhance, and restore quality wetland habitat for all native and desirable plant, wildlife, and fish species. Targeted animals include eagles, mussels, fish, turtles, migrating waterfowl, mammals, and waterbirds. Targeted plants include emergent vegetation such as arrowhead, burreed, and bulrush; submersed vegetation such as wild celery and sago pondweed; and floodplain vegetation such as swamp white oak, and button bush.

VI. IMPLEMENTATION CONSIDERATIONS

Backwater and channel maintenance dredging material could be used for topography enhancements; to provide sediment control; or to maintain, create, or enhance nearby islands.

VII. FINANCIAL DATA

All project lands are federally-owned and are managed by the U.S. Fish and Wildlife Service (USFWS) as part of the UMR National Wildlife and Fish Refuge. The estimated cost for the general planning, design, and construction of the actions noted in Section V is $13 million.

Since this project is located on a National Wildlife Refuge, it is 100 percent federally funded. The USFWS is the project sponsor and is responsible for operation and maintenance costs.

VIII. STATUS

The project was submitted to the Fish and Wildlife Interagency Committee on January 12, 2006 and accepted by the River Resources Coordinating Team on January 24, 2006 and reaffirmed in May 2010.

IX. POINTS OF CONTACT

Marshall Plumley, Program Manager, U.S. Army Corps of Engineers, Rock Island District, 309-794-5428
Ed Britton, USFWS, Savanna District Manager, 815-273-2732
Kirk Hansen, Mississippi River Wildlife Biologist, Iowa Department of Natural Resources, 563-872-5700

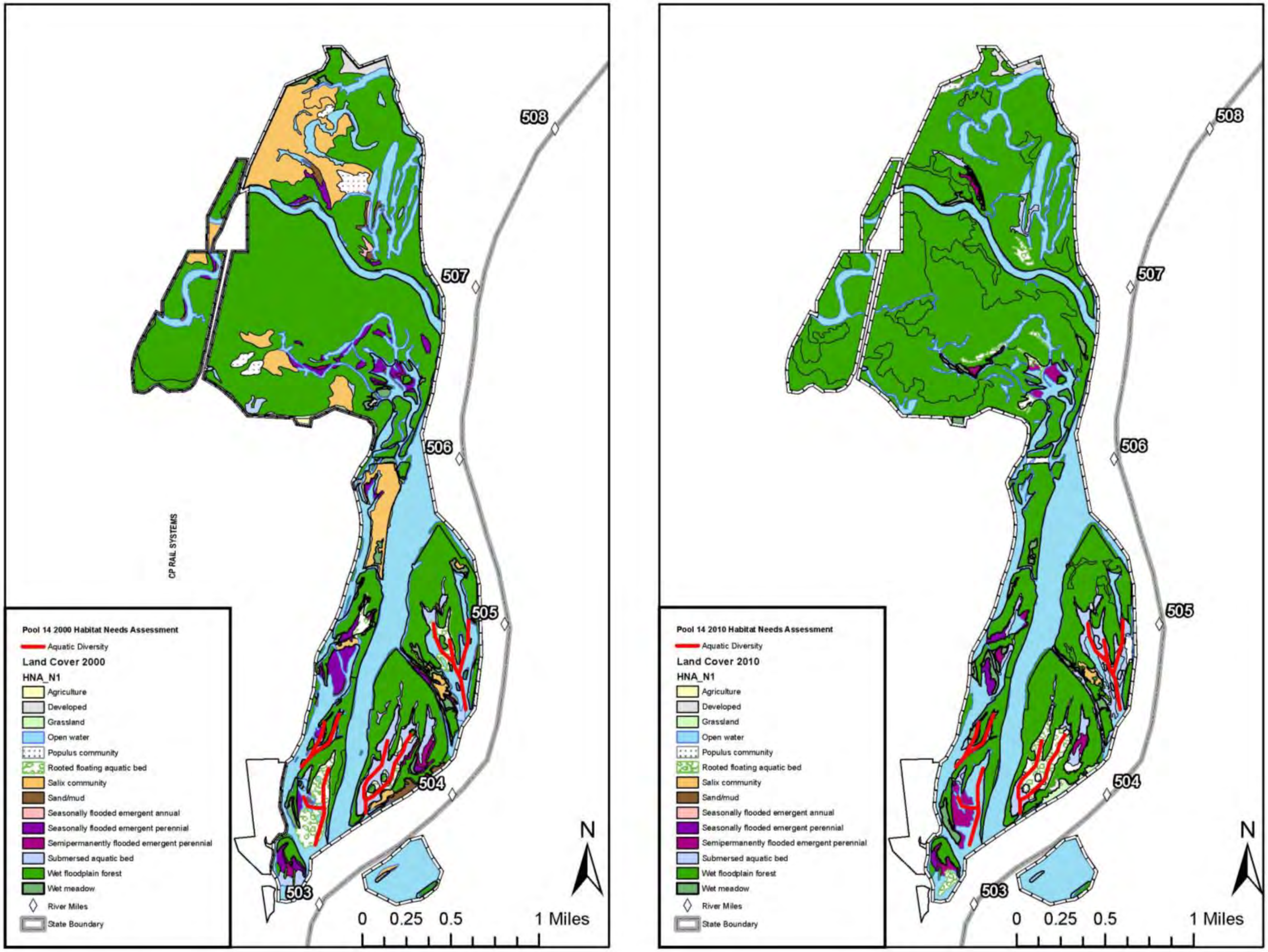

Figure 2. 2000 and 2010 Land Cover Data

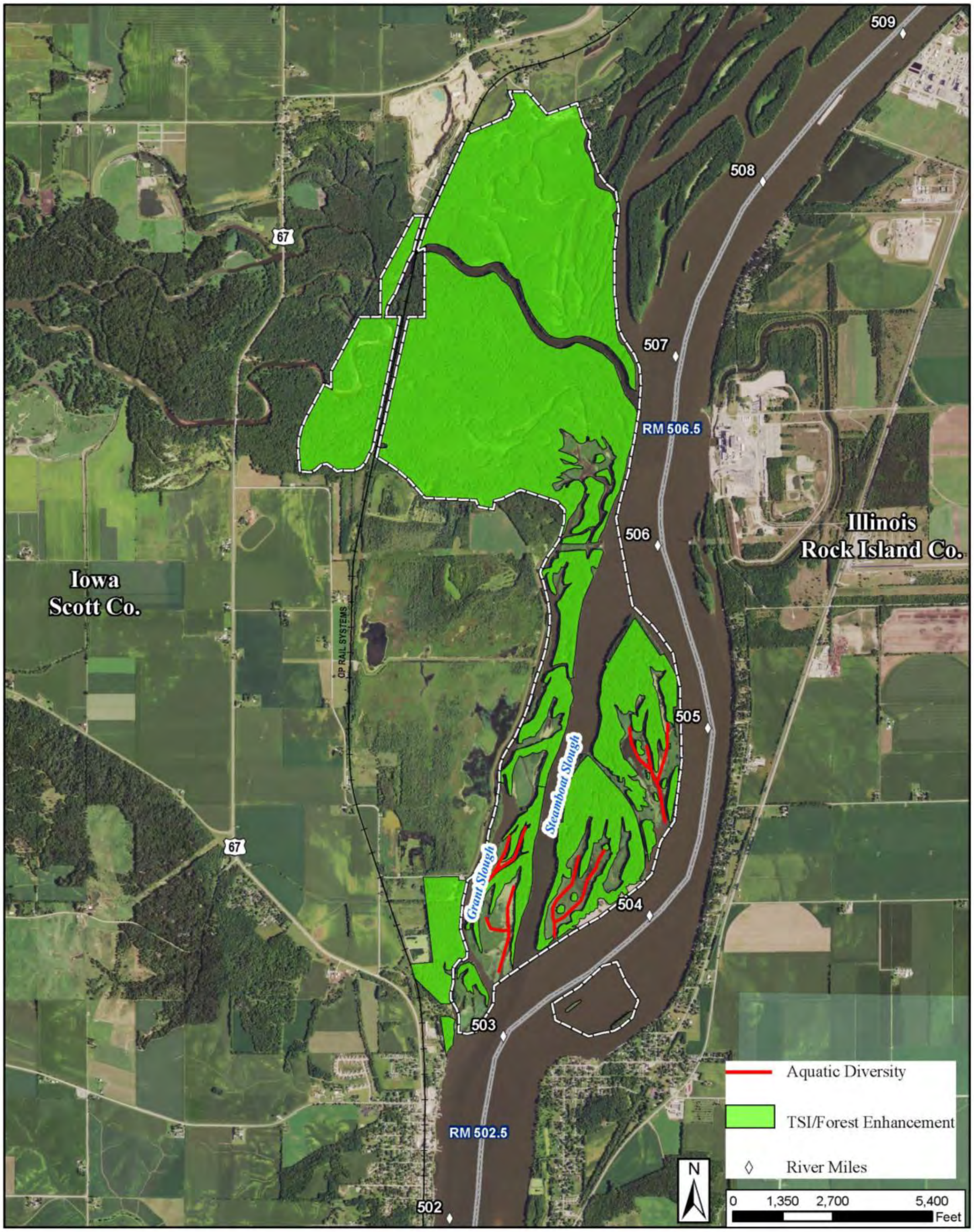

Figure 3. Proposed Project Features

DEPARTMENT OF THE ARMY
MISSISSIPPI VALLEY DIVISION, CORPS OF ENGINEERS
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080

REPLY TO
ATTENTION OF:

CEMVD-PD-SP 29 September 2010

MEMORANDUM FOR Commander, Rock Island District, ATTN: CEMVR-PM-M

SUBJECT: Upper Mississippi River Restoration - Environmental Management Program (UMRR-EMP), Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa, Fact Sheet

1. Reference memorandum, CEMVR-PM-M, 08 July 2010, subject as above.

2. Subject fact sheet is approved for continued HREP planning (encl 1).

3. The MVD point of contact is Elizabeth Ivy, CEMVD-PD-SP, [redacted]

Encl

CHARLES B. BARTON
Chief, District Support Team for
St. Louis, Rock Island, and
St. Paul

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT (HREP)
SCOTT COUNTY, IOWA,
UPPER MISSISSIPPI RIVER RESTORATION-ENVIRONMENTAL MANAGEMENT PROGRAM
ROCK ISLAND DISTRICT

FACT SHEET

I. LOCATION

The Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) is located on the right descending bank of the Mississippi River in Pool 14 of the Upper Mississippi River (UMR) within the UMR National Wildlife and Fish Refuge, between RM 503.5 to 505.5, approximately 1 mile above Princeton, Iowa. It is bound by the main channel on the north, east, and south and by Steamboat Slough on the west (figure 1). The Princeton State Wildlife Area is just west of the island.

II. EXISTING RESOURCES

This area includes backwater lakes, sloughs, flowing channels, and remnant islands. Though degraded, this important backwater area supports a diverse population of wildlife including ducks, geese, swans, pelicans, eagles, and muskrats. Figure 2 shows 1989 and 2000 land cover data for the project area.

III. PROBLEM IDENTIFICATION

Historically, Steamboat Island contained a number of small backwater lakes, sloughs, cuts, and flowing side channels. These habitats provided valuable overwintering, spawning, and feeding areas for a variety of fish, especially centrarchids. Migratory birds, including waterfowl, shorebirds, and wading birds also used the area extensively.

Years of silt deposition has allowed willows and silver maples to colonize the once-aquatic portions of the island, resulting in a degraded wetland complex. In addition, impoundment of the pool and permanently higher water tables have affected the health of floodplain habitat on islands and adjacent floodplain areas. These higher water tables are affecting forest composition and regeneration.

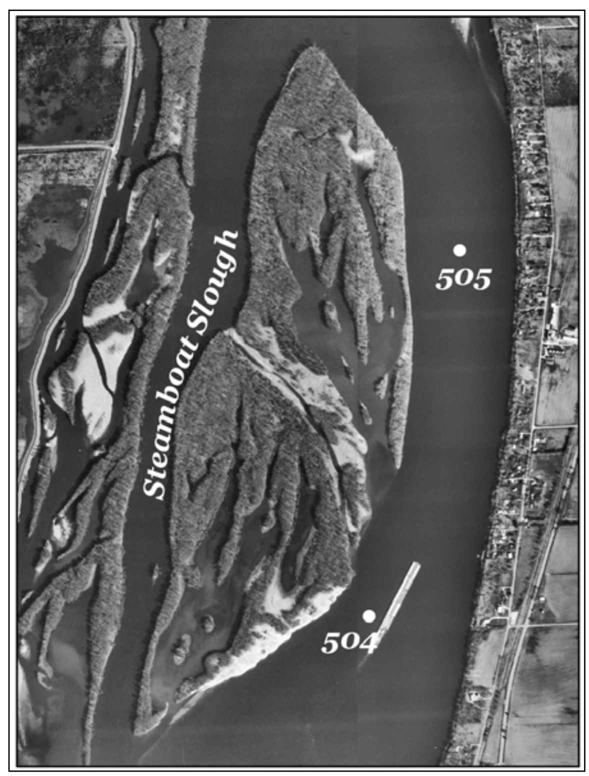

Figure 1. General Project Location

IV. PROJECT GOALS AND OBJECTIVES

Project goals are derived from the Environmental Pool Plans, Pools 11 through 22; the Habitat Needs Assessment; and Reach Planning efforts. These project goals are consistent with the systemic goals adopted by the Environmental Management Program Coordinating Committee and the Navigation Environmental Coordination Committee in January of 2008.

Maintain, Enhance and Create Quality Habitat for all Native and Desirable Plant, Animal and Fish Species

- protect, enhance, and restore aquatic habitat for viable populations of fish, invertebrates, aquatic and semi-aquatic mammals, reptiles, amphibians, waterfowl, shorebirds, etc.
- protect, enhance, and restore floodplain habitat for viable populations of the variety of mammals, birds, reptiles, amphibians, etc.

Maintain, Enhance, Restore, and Emulate Natural River Processes, Structures and Functions for a Sustainable Ecosystem

- stabilize flows throughout the complex
- restore sediment transport and deposition throughout the complex to a more "natural" condition
- manage pool water elevations to emulate more natural seasonal water elevations
- minimize adverse effects of elevated water table on soil moisture conditions

V. PROPOSED PROJECT FEATURES

The proposed project includes backwater dredging to provide critical overwintering habitat for fish such as bass, crappie, yellow perch, and bluegill. The increase in wetland diversity would restore feeding habitat for resident and migratory birds. Dredged material could be used to create topographic diversity on the islands, to provide sediment control, or to maintain, create, or enhance nearby islands. Forest diversity could be accomplished by elevating islands, planting hardwoods, and forest management (figure 3).

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VI. IMPLEMENTATION CONSIDERATIONS

Backwater and channel maintenance dredging material could be used for topography enhancements; to provide sediment control; or to maintain, create, or enhance nearby islands.

VII. FINANCIAL DATA

All project lands are federally-owned by the Corps of Engineers and are managed by the U.S. Fish and Wildlife Service (USFWS) as part of the UMR National Wildlife and Fish Refuge. The estimated cost for the general planning, design, and construction of the actions noted in Section V is $6 million. Since this project is located on a National Wildlife Refuge, it is 100 percent federally funded. The USFWS is the project sponsor and is responsible for operation and maintenance costs.

VIII. STATUS

The project was submitted to the Fish and Wildlife Interagency Committee on January 12, 2006 and accepted by the River Resources Coordinating Team on January 24, 2006 and reaffirmed in May 2010.

IX. POINTS OF CONTACT

Marvin Hubbell, Program Manager, U.S. Army Corps of Engineers, Rock Island District, [redacted]
Ed Britton, USFWS, Savanna District Manager, [redacted]
Mike Griffin, Mississippi River Wildlife Biologist, Iowa Department of Natural Resources, [redacted]

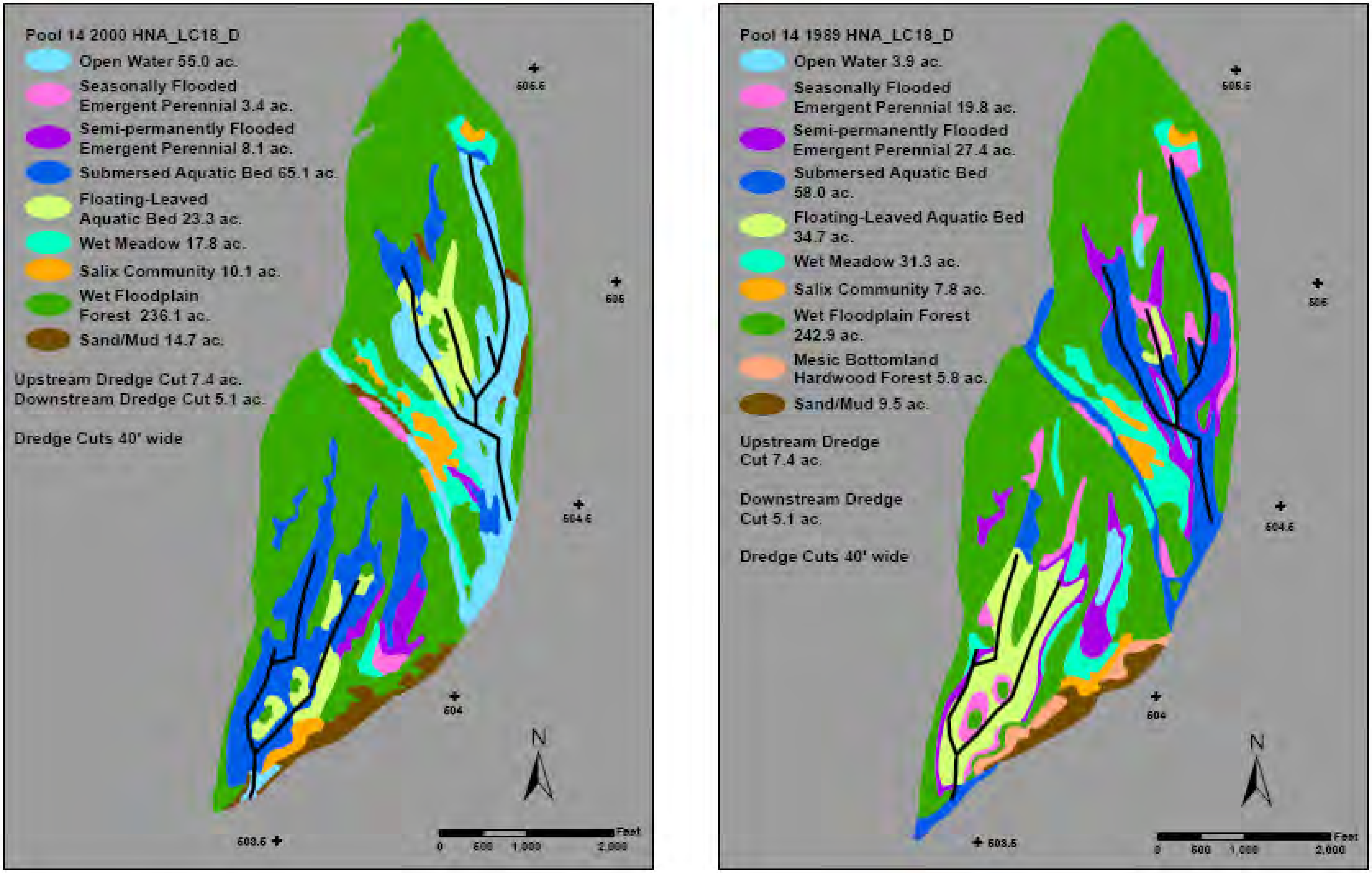


Figure 2. 1989 and 2000 Land Cover Data

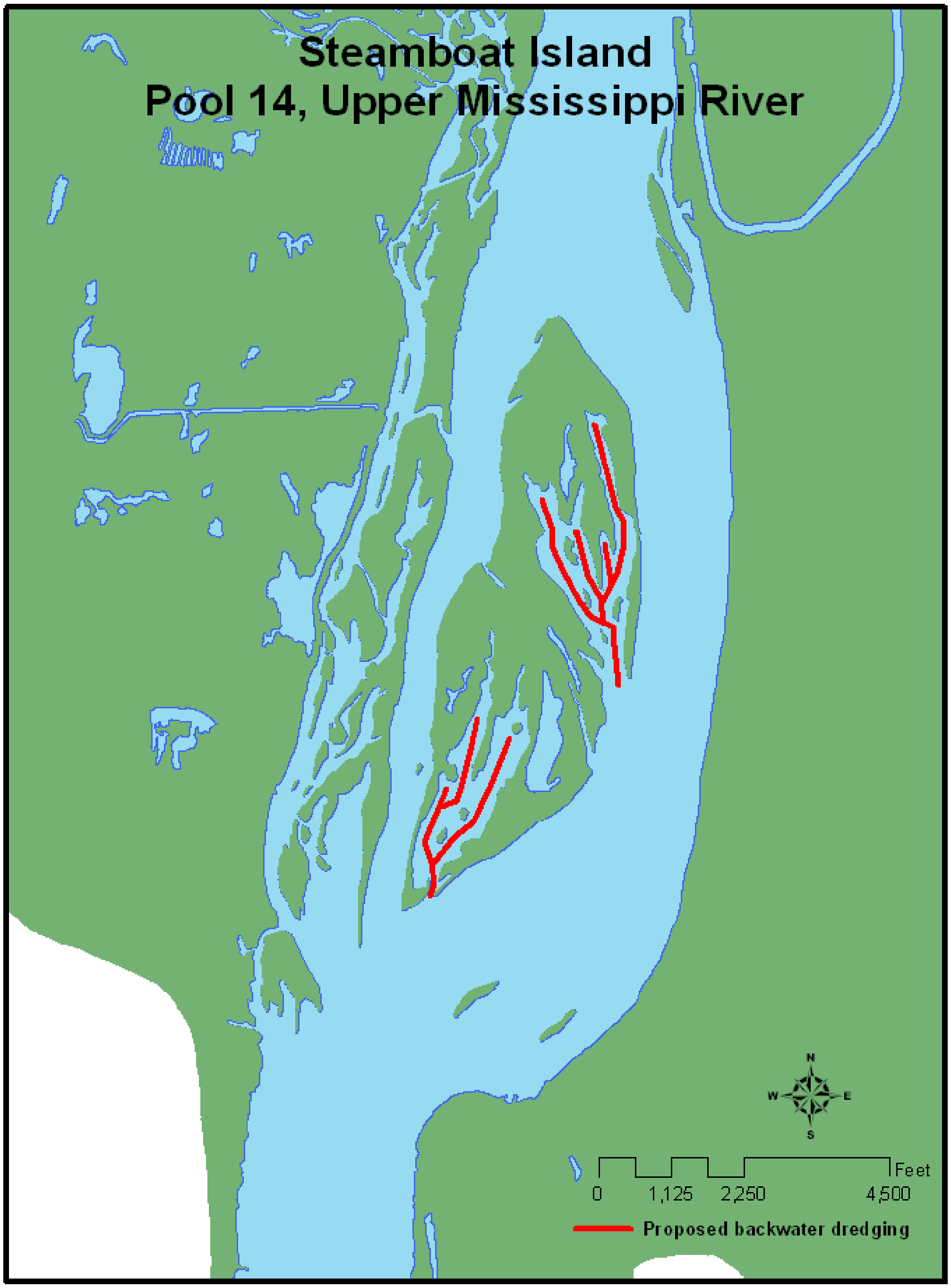


Figure 3. Proposed Project Features

Pesi 1027.06

FINAL REPORT
ASSESSMENT OF NATIVE AND NON-INDIGENOUS MUSSEL SPECIES FOR THE STEAMBOAT ISLAND HREP AT POOL 14 OF THE UPPER MISSISSIPPI RIVER IN SCOTT COUNTY, IOWA.

09 November 2018

Prepared for:

U.S. Army Corps of Engineers – Rock Island District
1500 Rock Island Drive
Rock Island, Illinois 61201

Contract No. W912EK-16-D-0010

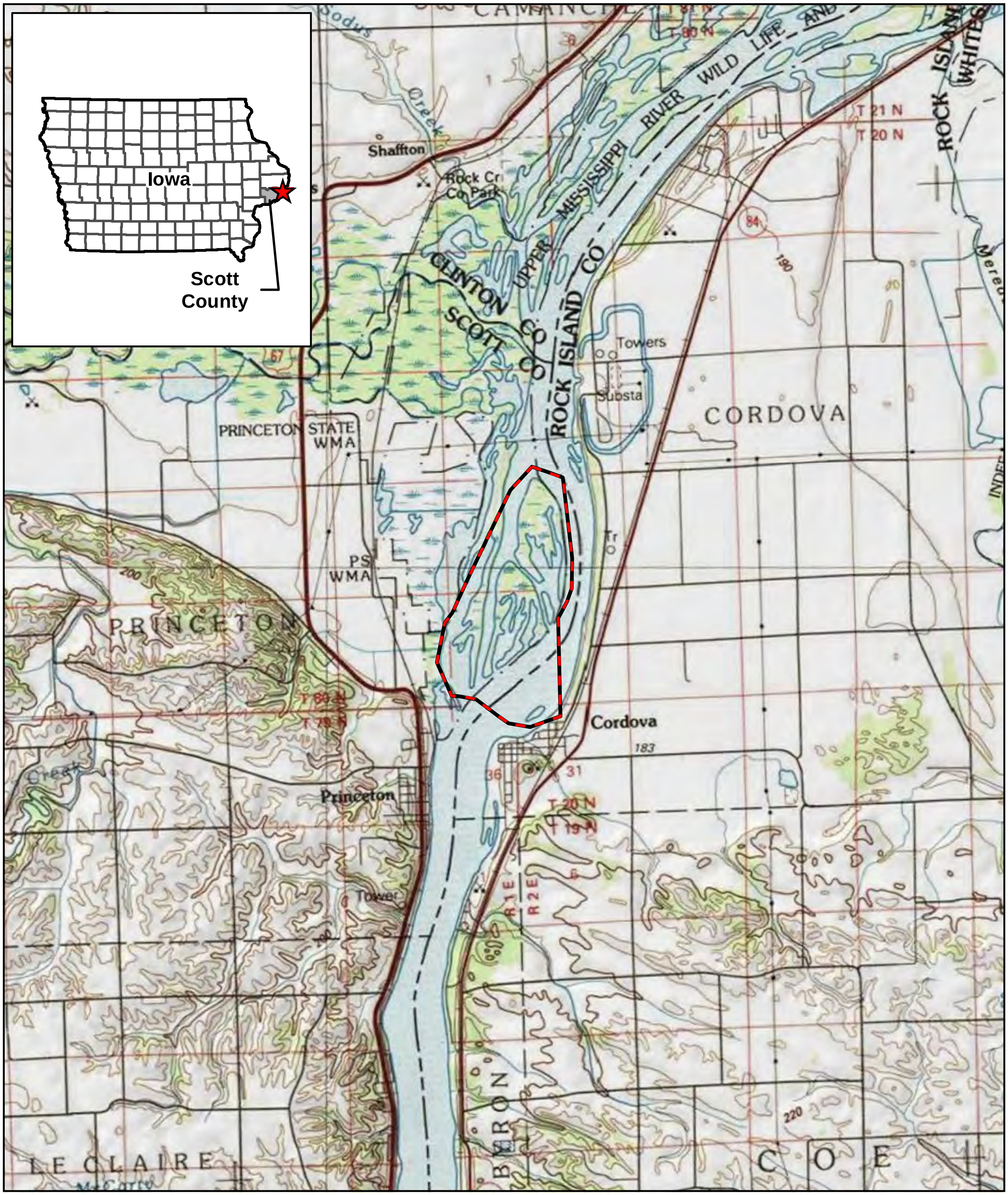
Prepared by:

ESI

Environmental Solutions & Innovations, Inc.

4525 Este Avenue
Cincinnati, Ohio 45232
Phone: (513) 451-1777
Fax: (513) 451-3321
Stow, OH • Indianapolis, IN • Orlando, FL • Springfield, MO • Pittsburgh, PA • Teays Valley, WV

FIGURES



Area of Investigation (AOI)

N
W E
S

Figure 1. Location of freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Project No. 1027.06

1,000 0 1,000 2,000 Meters

Base Map: ESRI "USGS Topographic Map"

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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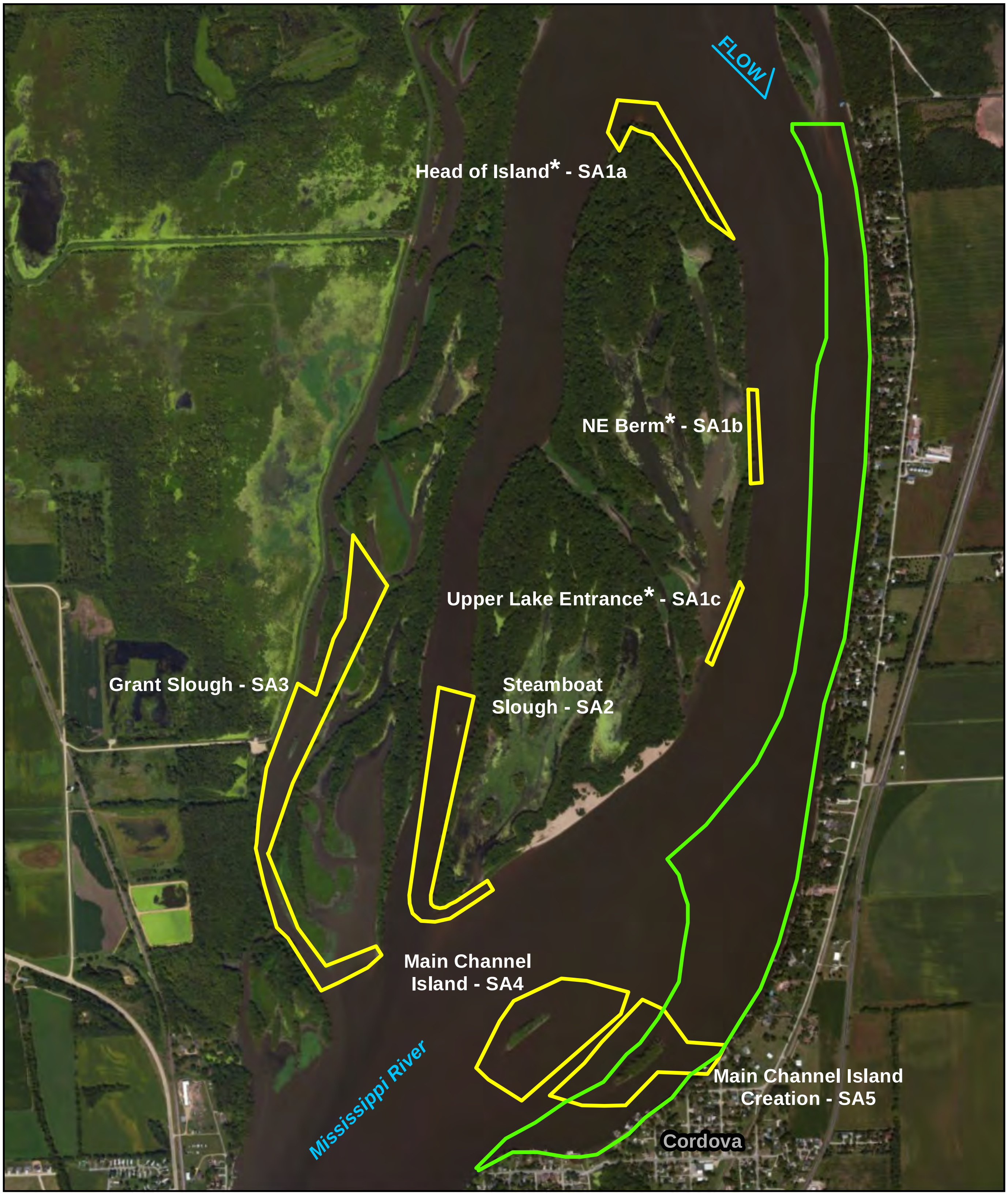

Cordova Essential Habitat Area (EHA) Study Area (SA) *Steamboat Island Complex - SA1

N W E S

Figure 2. Freshwater mussel survey extent in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) Area in the Upper Mississippi River in Scott County, Iowa.

Project No. 1027.06

250 0 250 500 Meters

Base Map: ESRI "World_Imagery (Clarity)"

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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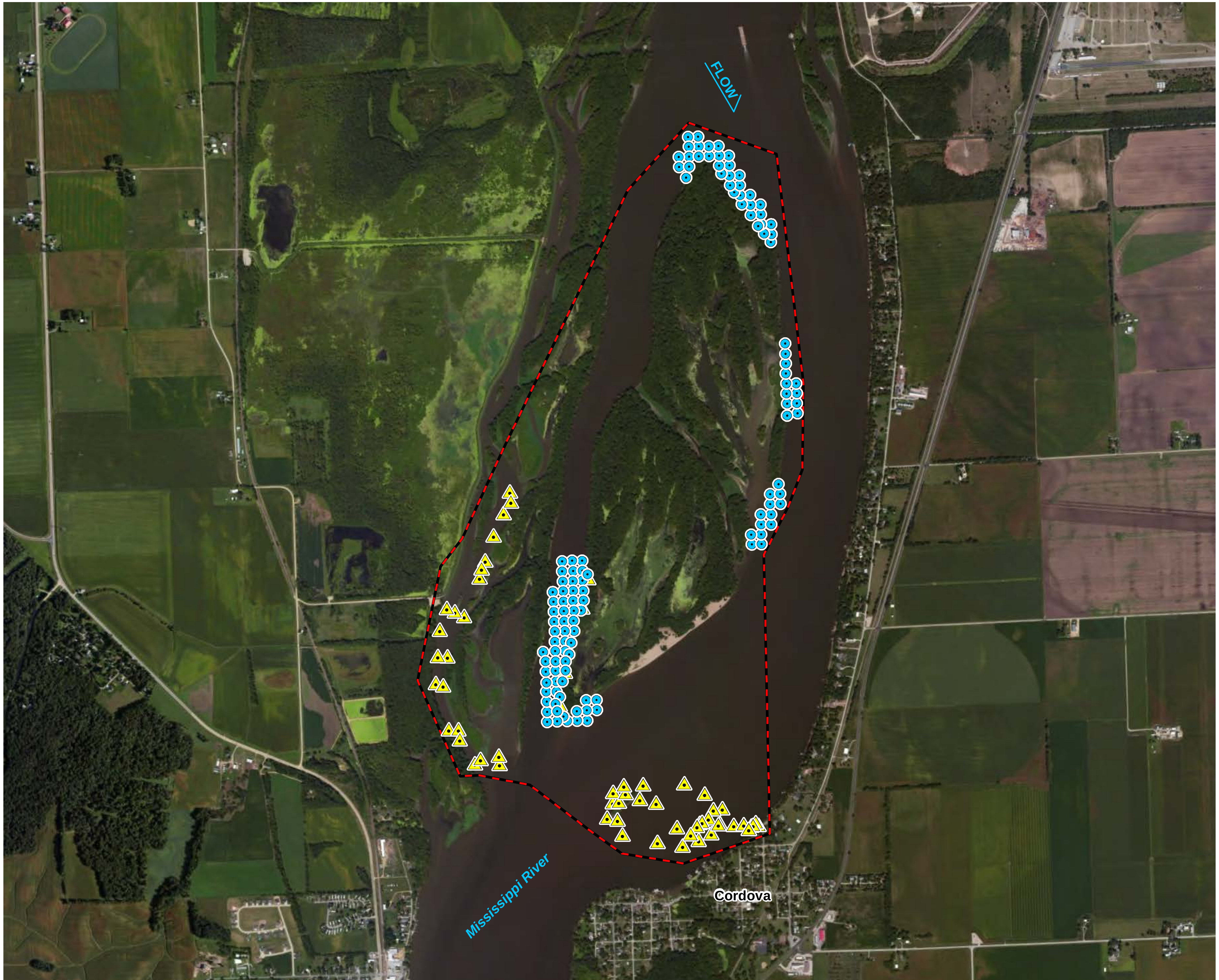

Figure 3. Quantitative and qualitative sample locations in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.

Quantitative Sampling Location (123)
Qualitative Sampling Location (60)
Area of Investigation (AOI)

N
W E
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Meters
250 0 250 500

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/11/2018

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1027.06

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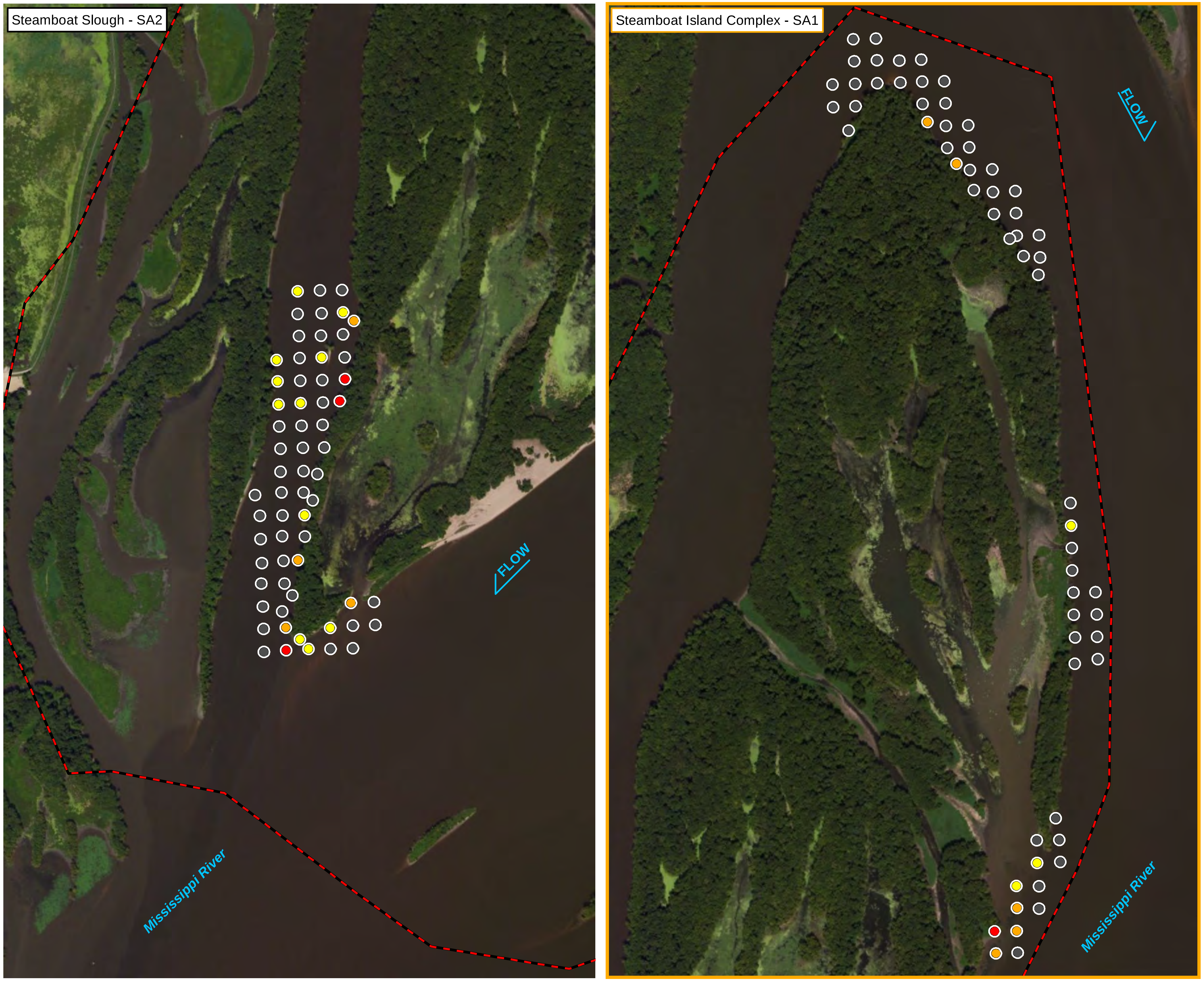
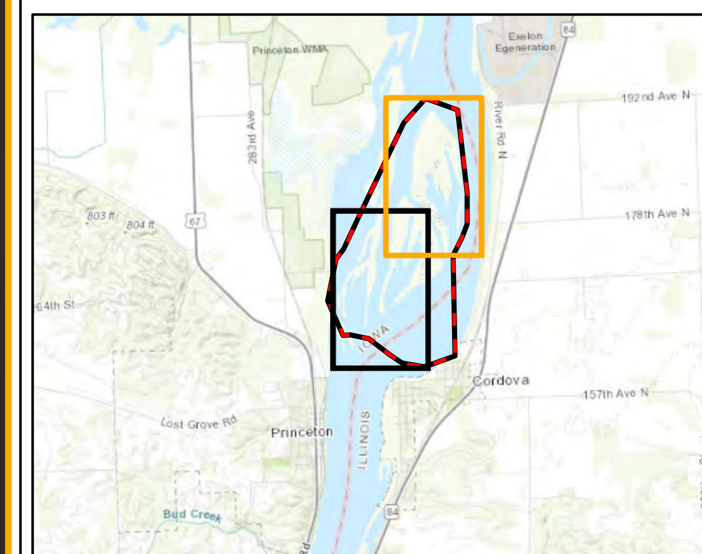
Figure 4. Quantitative mussel abundance for freshwater mussel surveys at Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.



Mussel Abundance (no./0.25m²)

- 0 (96)
- 1 (14)
- 2 - 4 (9)
- 5 - 6 (4)
- Area of Investigation (AOI)



N
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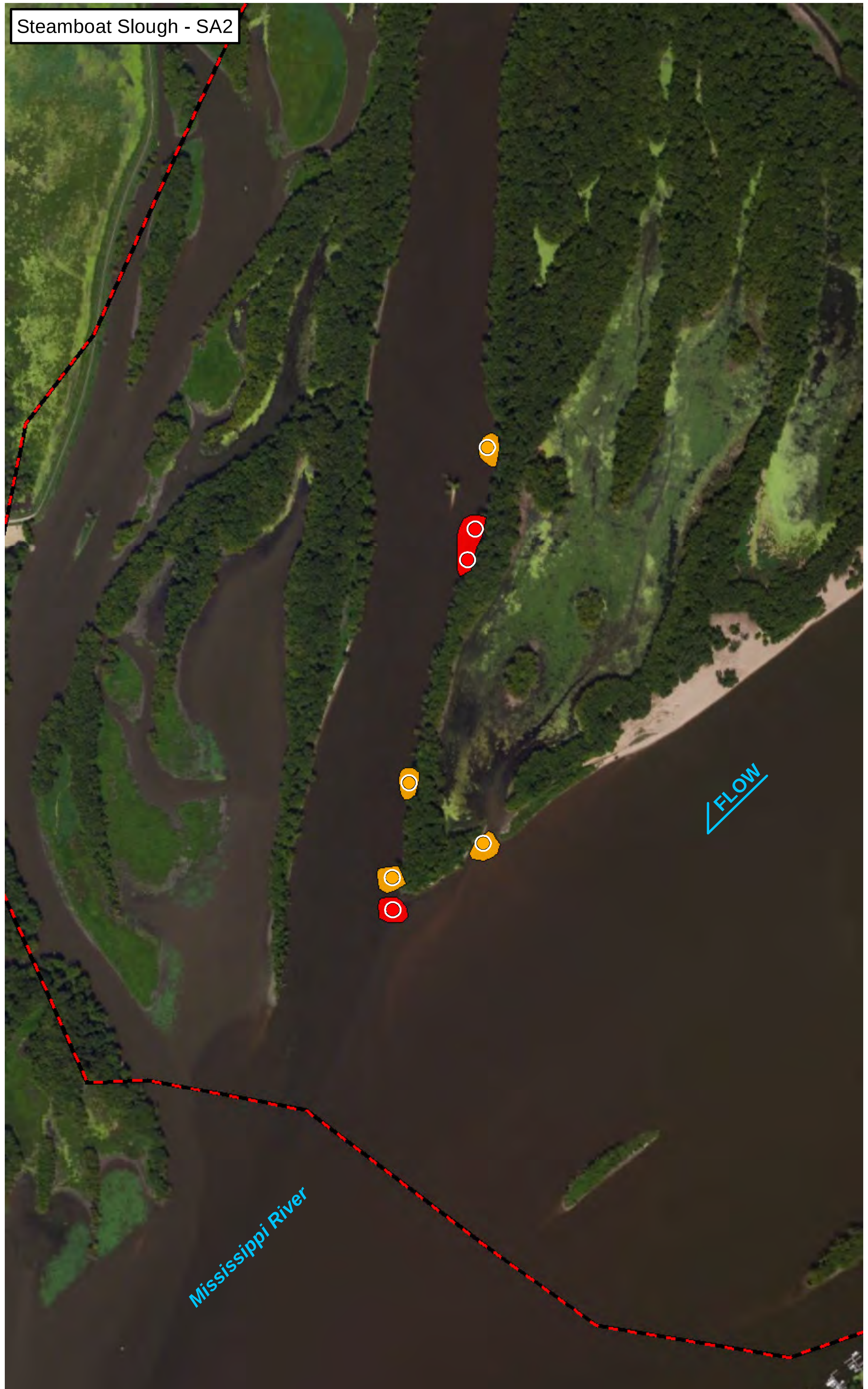
Meters
110 0 110 220

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC

1027.06



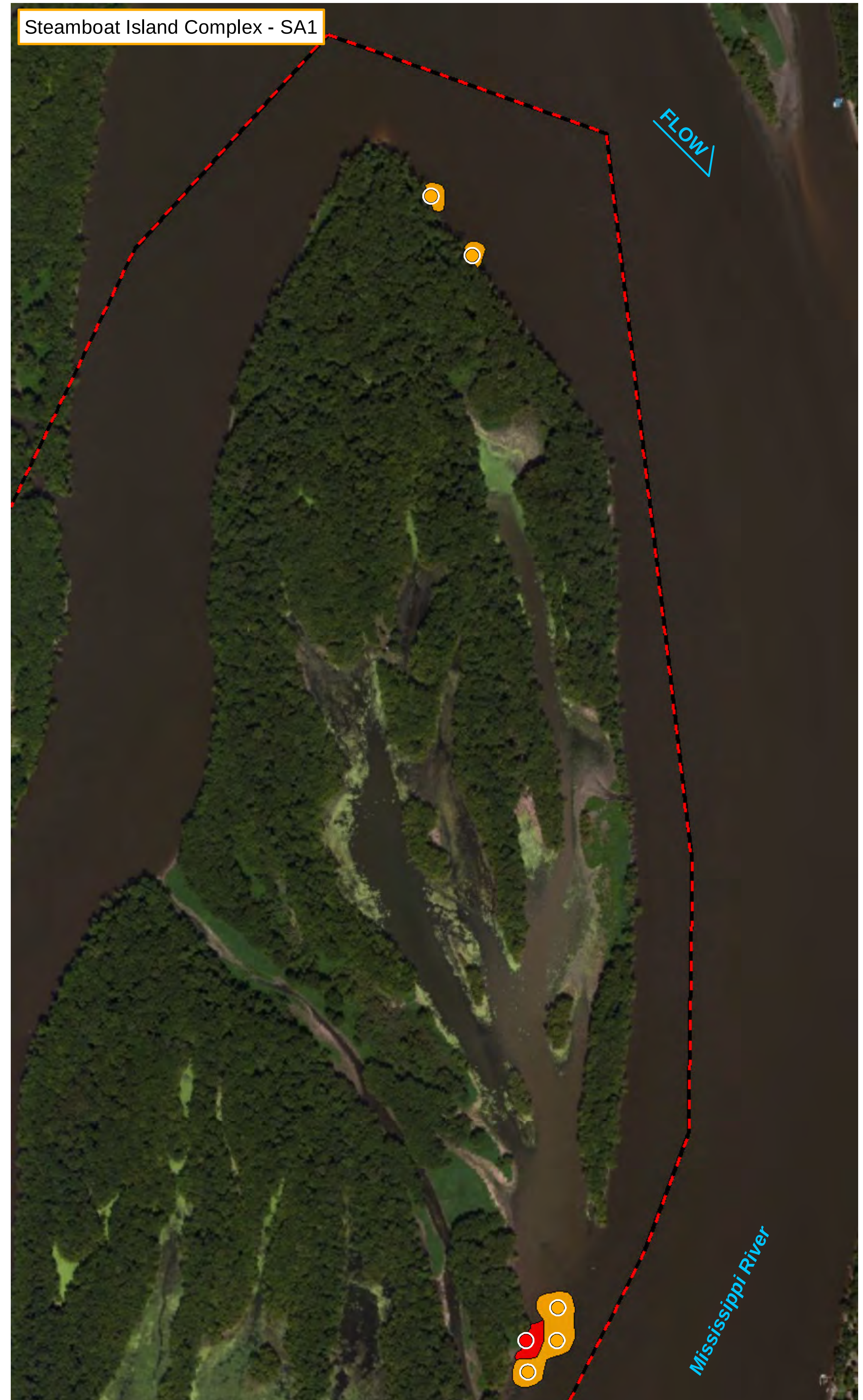
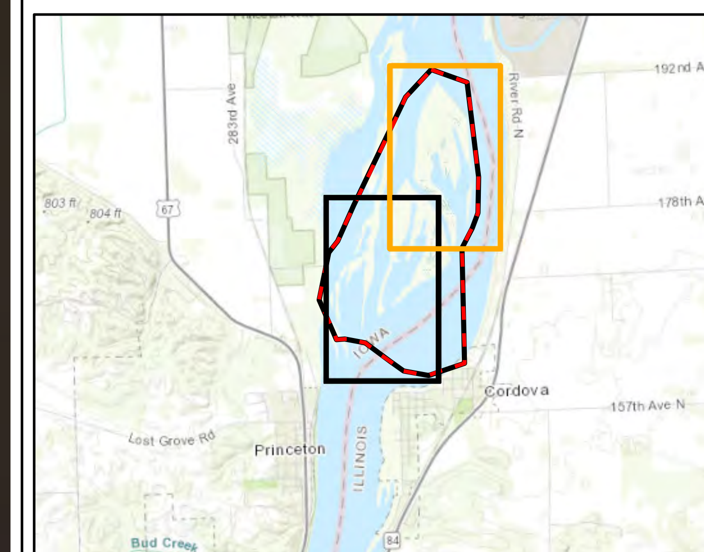


Figure 5. Extrapolated mussel densities in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.

Mussel Abundance (no./0.25m²)

Abundance

- 2 - 4 (9)
- 5 - 6 (4)
- Area of Investigation (AOI)



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Meters
110 0 110 220

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC

1027.06

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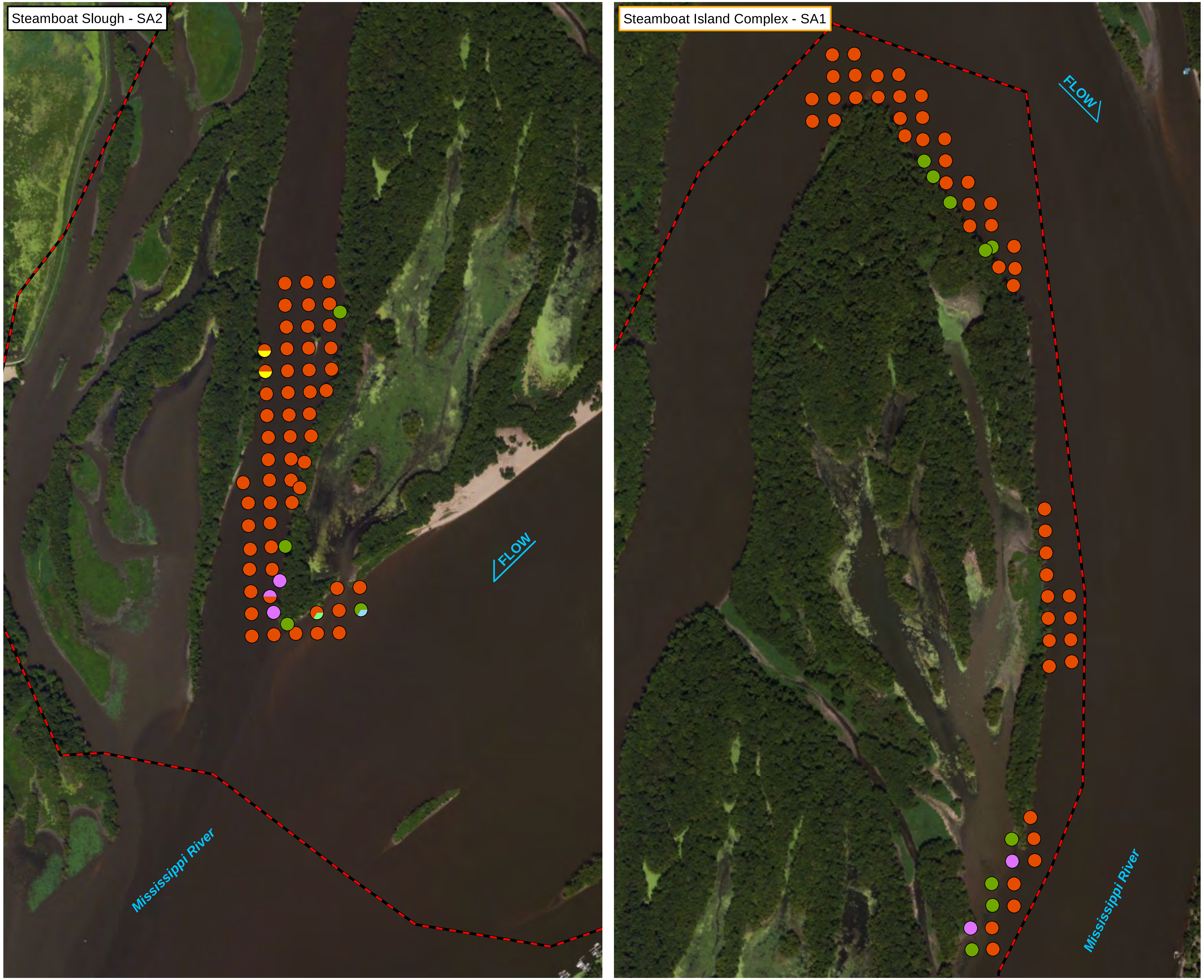
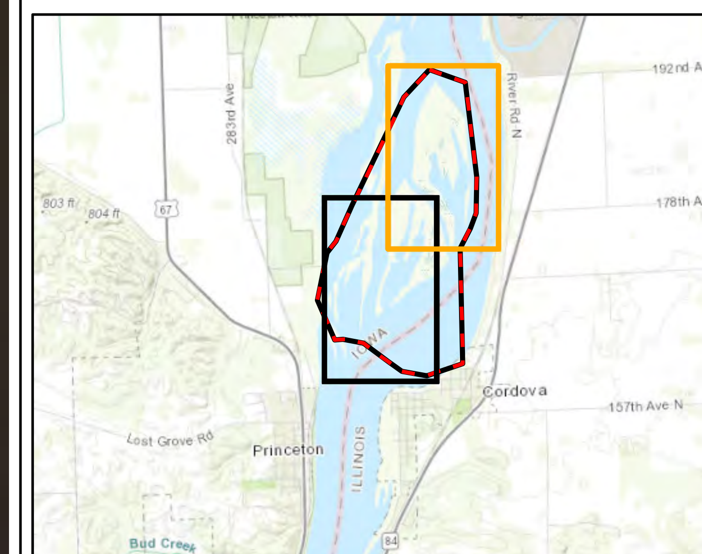
Figure 6. Quantitative sample substrate composition during freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.



Quantitative Sampling Location

- clay
- fines
- sand
- gravel
- cobble
- boulder
- bedrock_hardpan
- other
- Area of Investigation (AOI)



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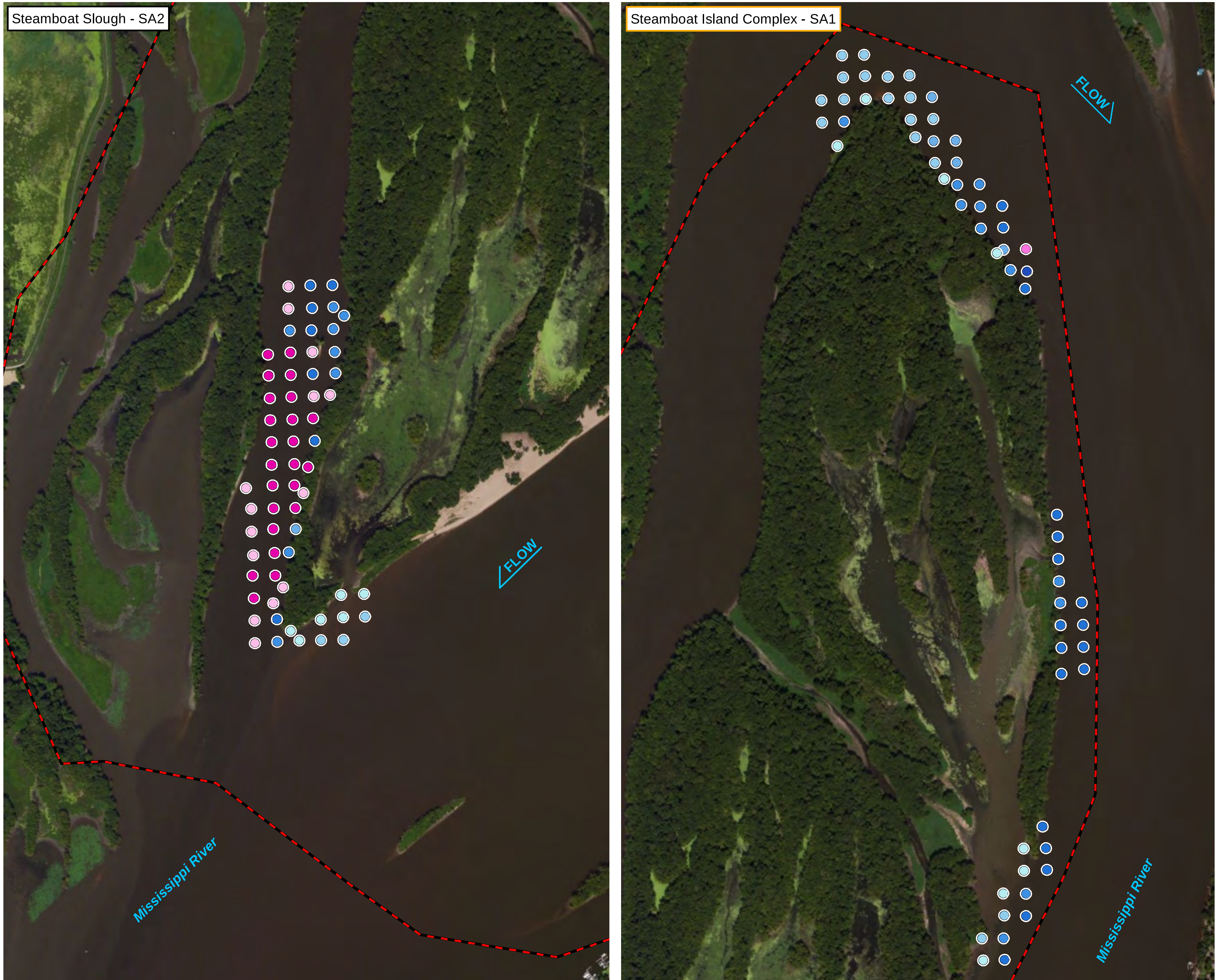
110 0 110 220

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC

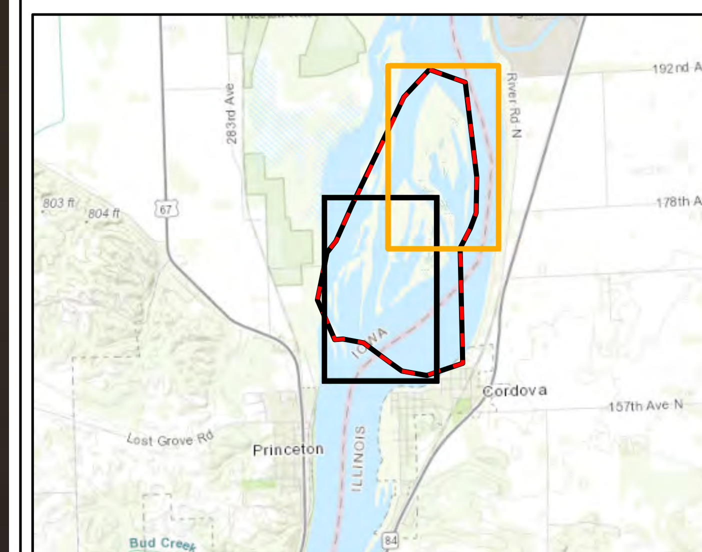
1027.06

Figure 7. Sample depth of quantitative freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.



Depth (meter)

- 0.5 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0
- 6.1 - 7.3
- Area of Investigation (AOI)



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Meters
110 0 110 220

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC
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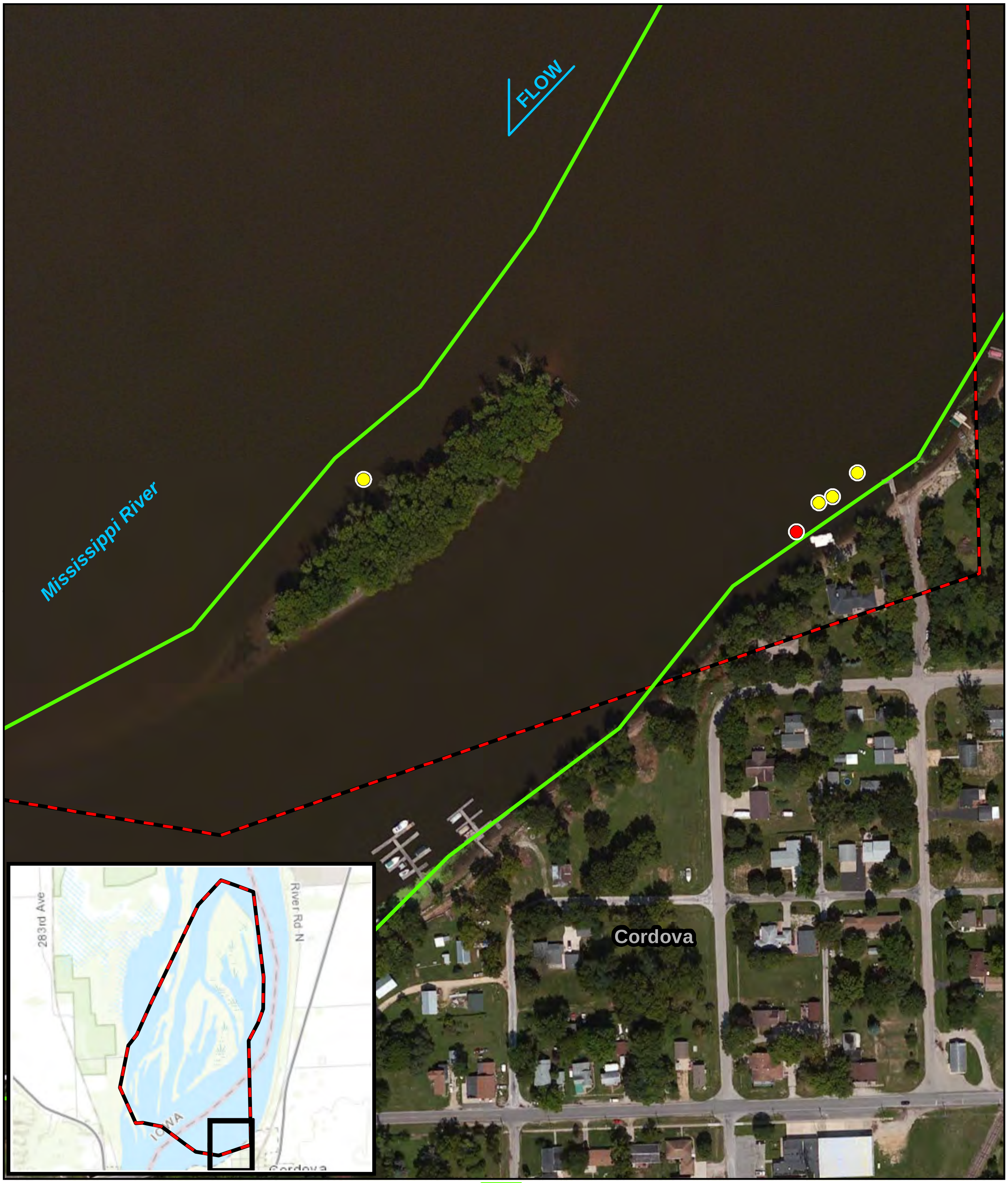

Higgins eye pearlymussel abundance
- 1
- 2

Cordova Essential Habitat Area (EHA)
Area of Investigation (AOI)

N
W E
S

Figure 8. Occurrence and abundance of Higgins eye pearlymussel (*Lampsilis higginsii*) in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.

Project No. 1027.06

40 0 40 80 Meters

Base Map: ESRI "World_Imagery (Clarity)"

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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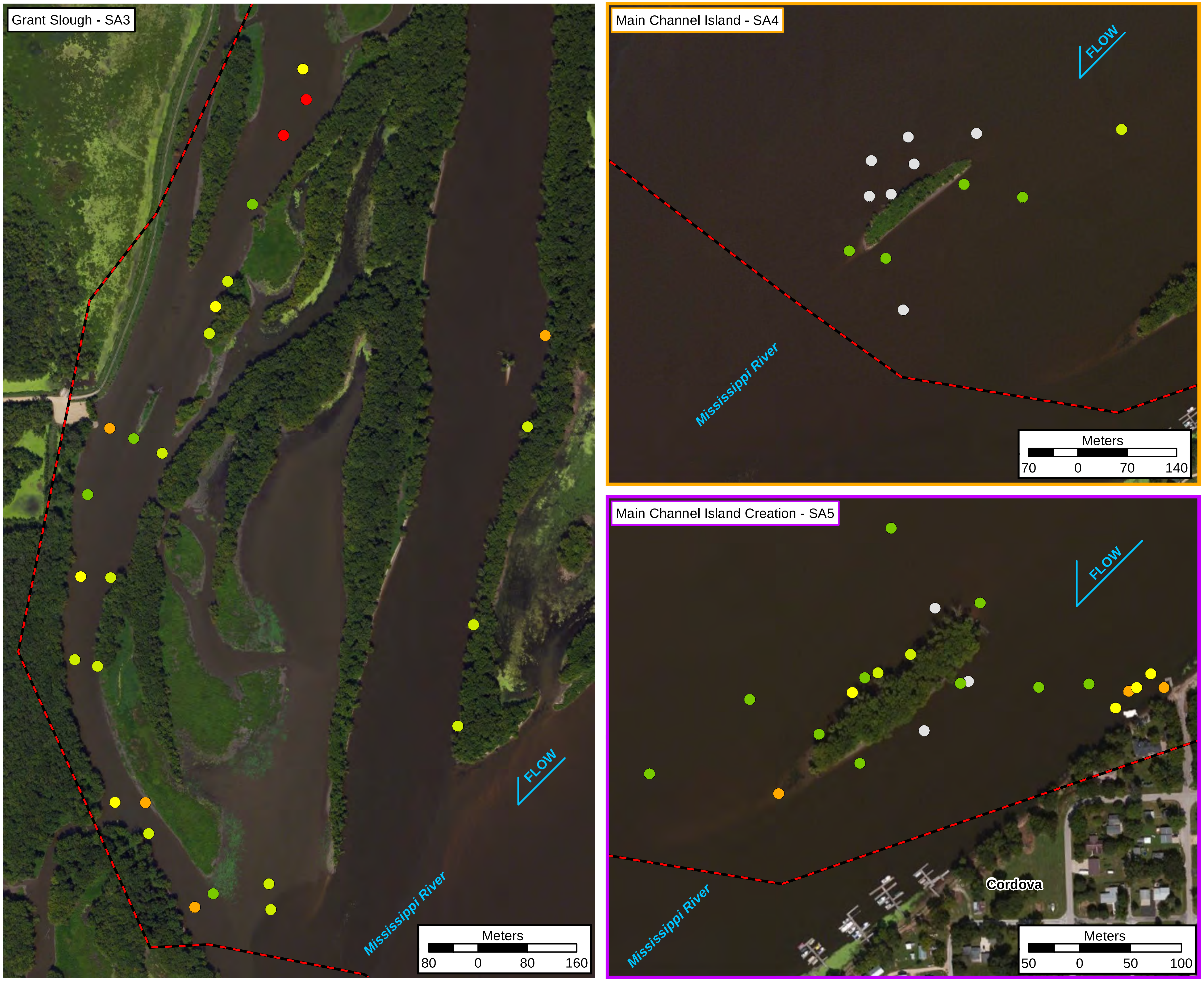
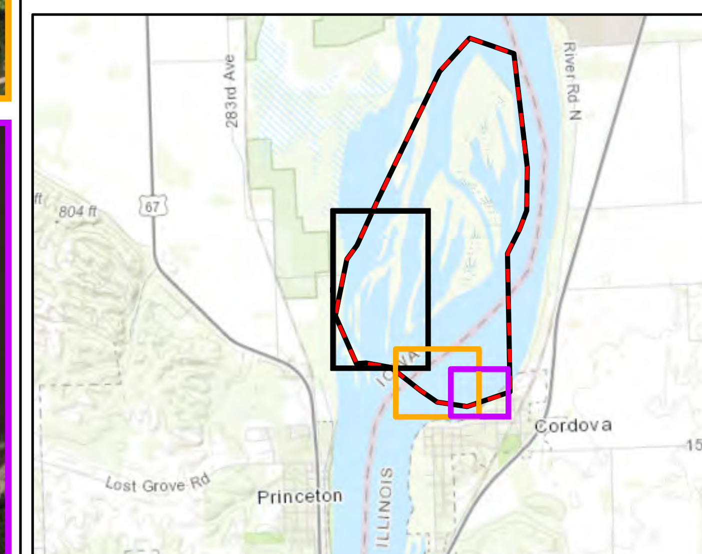


Figure 9. Qualitative mussel abundance for freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.

Catch per unit effort (CPUE) (live mussels per hour)

- 0
- 1 - 50
- 51 - 150
- 151 - 250
- 251 - 350
- 351 - 516
- Area of Investigation (AOI)



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Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

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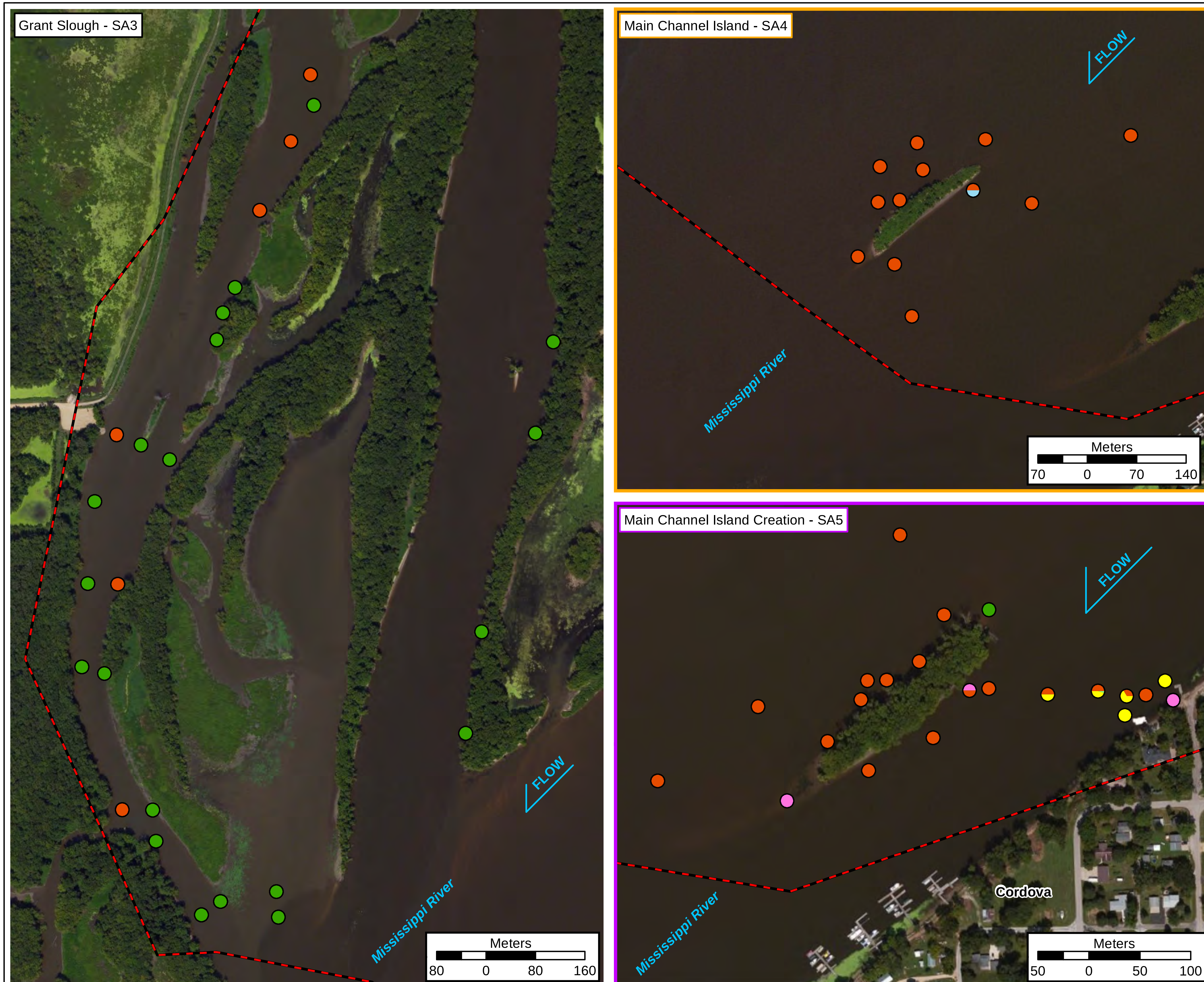
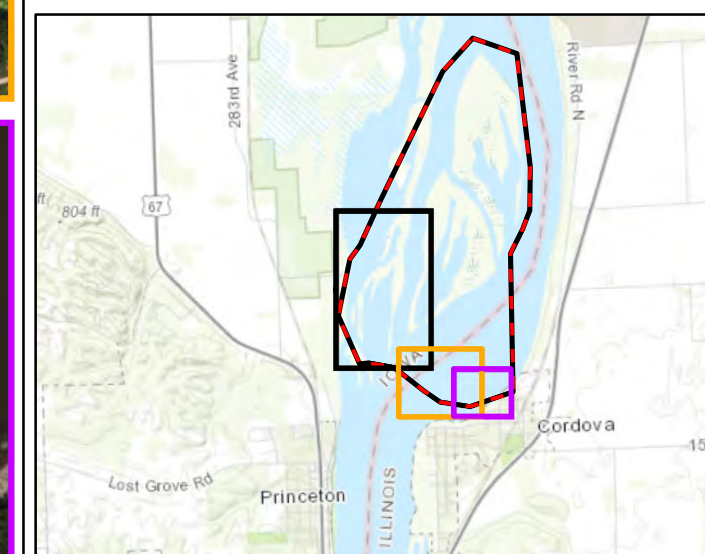


Figure 10. Substrate composition during qualitative freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.

Qualitative Sampling Location

- clay
- fines
- sand
- gravel
- cobble
- boulder
- bedrock_hardpan
- other
- Area of Investigation (AOI)



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Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

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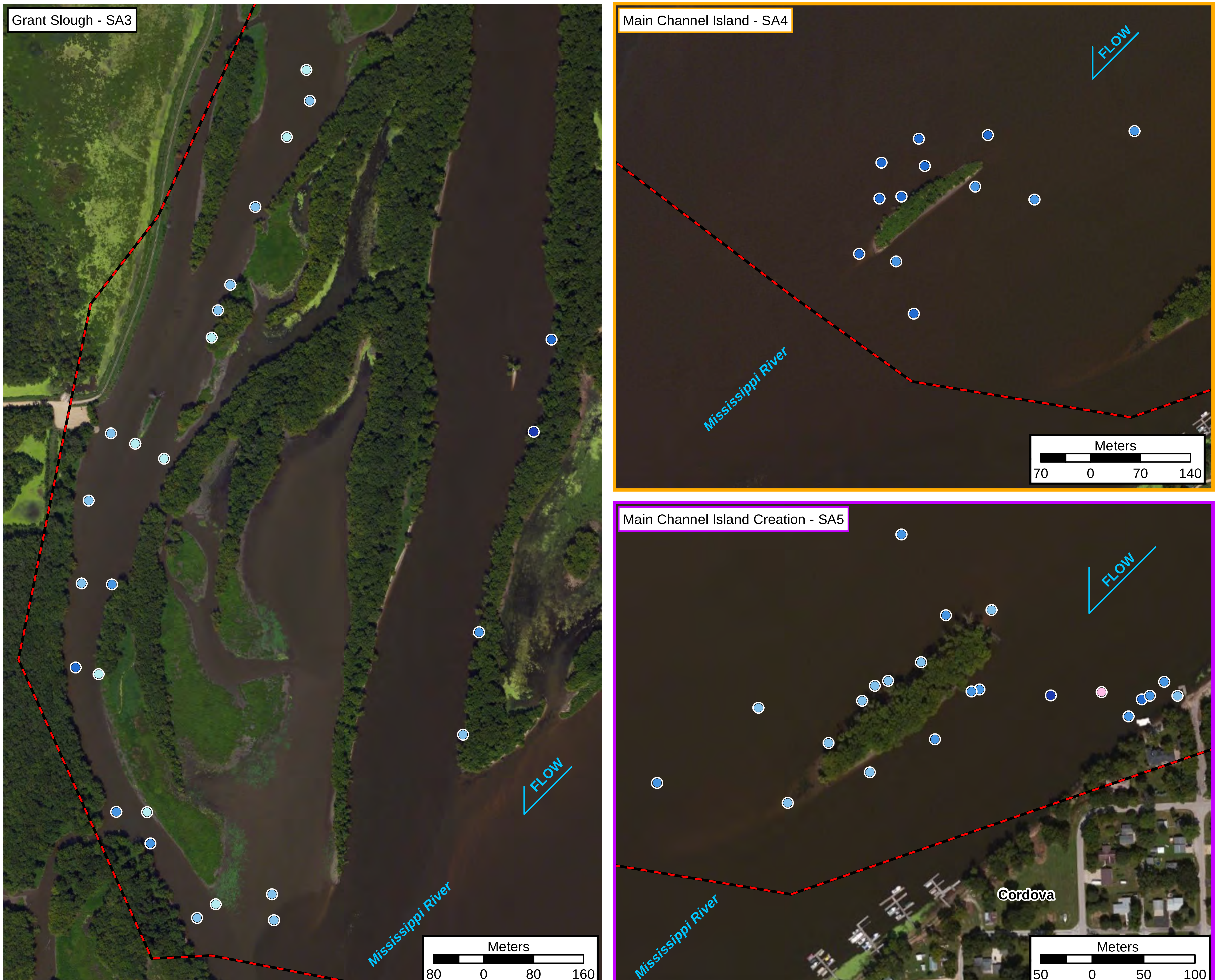
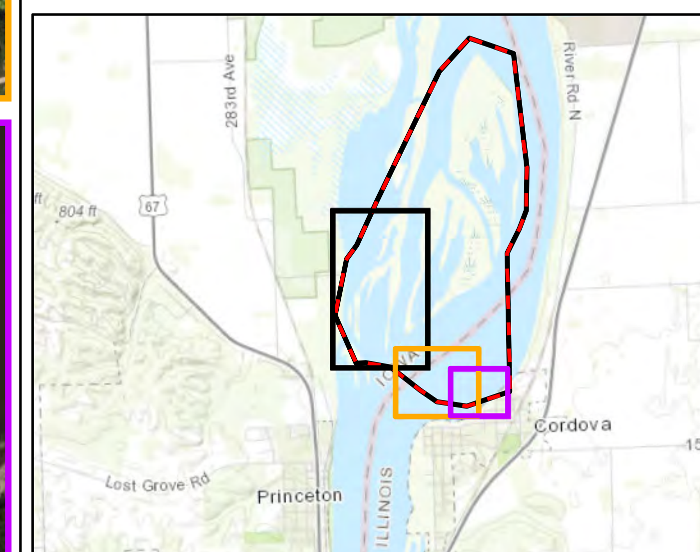


Figure 11. Sample depth of qualitative freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.

Depth

- 0.6 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 5.2
- Area of Investigation (AOI)



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Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

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TABLES

Table 1. Historical unionid species list for Pool 14 in the Upper Mississippi River near Scott County, Iowa.

Mussel Species		
Scientific Name[1]	Common Name	Status[2]
Amblemini		
Amblema plicata	threeridge	
Anodontini		
Anodonta suborbiculata	flat floater	
Arcidens confragosus	rock pocketbook	
Lasmigona complanata	white heelsplitter	
Lasmigona compressa	creek heelsplitter	
Lasmigona costata	fluted shell	
Pyganodon grandis	giant floater	
Strophitus undulatus	creeper	IA_T
Utterbackia imbecillis	paper pondshell	
Lampsilini		
Actinonaias ligamentina	mucket	
Ellipsaria lineolata	butterfly	IL_T, IA_T
Epioblasma triquetra	snuffbox	FE, IL_E
Lampsilis cardium	plain pocketbook	
Lampsilis higginsii	Higgins eye pearlymussel	FE, IA_E, IL_E
Lamsilis siliquoidea	fatmucket	
Lampsilis teres	yellow sandshell	IA_E
Leptodea fragilis	fragile papershell	
Ligumia recta	black sandshell	IL_T
Obliquaria reflexa	threehorn wartyback	
Obovaria olivaria	hickorynut	
Potamilus alatus	pink heelsplitter	
Potamilus capax	fat pocketbook	FE, IL_E
Potamilus ohiensis	pink papershell	
Toxolasma parvum	liliput	
Truncilla donaciformes	fawnsfoot	
Truncilla truncata	deertoe	
Margaritiferidae		
Cumberlandia monodonta	spectaclecase	FE, IA_E, IL_E
Pleurobemini		
Cyclonaias nodulata	wartyback	
Cyclonaias pustulosa	pimpleback	
Cyclonaias tuberculata	purple wartyback	IL_T, IA_T
Elliptio crassidens	elephant ear	IL_E
Eurynia dilatata	spike	IL_T
Fusconaia ebena	ebonyshell	IL_E
Fusconaia flava	Wabash pigtoe	
Plethobasus cyphyus	sheepnose	FE, IA_E, IL_E
Pleurobema sintoxia	round pigtoe	IA_E
Quadrulini		
Megalonaias nervosa	washboard	
Theliderma metanevra	monkeyface	
Quadrula quadrula	mapleleaf	
Tritogonia verrucosa	pistolgrip	IA_E

[1]Scientific nomenclature derived from Williams et al. 2017

[2]FE = federally endangered, IA_E = Iowa endangered, IA_T = Iowa threatened, IL_E = Illinois endangered, IL_T = Illinois threatened

Table 2. Summary of quantitative and qualitative samples collected in Pool 14 at the Steamboat Island Habitat Restoration and Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Location		Study Area	Survey Area (m^2)	Quantitative Efforts: Sample Area (m^2)	Quantitative Efforts: No. Samples	Quantitative Efforts: Total Area Sampled (m^2)	Qualitative Efforts: No. Samples	Qualitative Efforts: Sample Duration (min)	Qualitative Efforts: Total Time (min)
Pool 14	1	Steamboat Island Complex	60,581	0.25	61	15.25	0	0	0
	2	Steamboat Slough	91,418	0.25	62	15.5	4	5	20
	3	Grants Slough	151,798	0	0	0	22	5	110
	4	Main Channel Island	126,302	0	0	0	12	5	60
	5	Main Channel Island Creation	108,537	0	0	0	22	5	110
		Total	538,636		123	30.75	60		300

Table 3. Unionid species collected during 2018 quantitative and qualitative mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Mussel Species		Quantitative				Qualitative					
Scientific Name	Common Name	No. live	Rel. Abund. (%)	No. FD[1]	No. ≤5y	No. live	Rel. Abund. (%)	No. FD[1]	No. ≤5y	Total	%
Amblemini											
Amblema plicata	threeridge	12	21.4	1	10	231	42.5	5	84	243	40.5
	Subtotal	12	21.4	1	10	231	42.5	5	84	243	40.5
Anodontini											
Arcidens confragosus	rock pocketbook	-	-	-	-	2	0.4	1	0	2	0.3
Lasmigona complanata	white heelsplitter	-	-	-	-	6	1.1	(WD)	0	6	1.0
Pyganodon grandis	giant floater	1	1.8	(WD)	0	14	2.6	1	0	15	2.5
Utterbackia imbecillis	paper pondshell	3	5.4	1	3	1	0.2	1	1	4	0.7
	Subtotal	4	7.2	1	3	23	4.2	3	1	27	4.5
Lampsilini											
Actinonaias ligamentina	mucket	0	0.0	(SF)	0	0	0.0	(SF)	0	0	0
Ellipsaria lineolata	butterfly	-	-	-	-	1	0.2	(WD)	0	1	0.2
Lampsilis cardium	plain pocketbook	1	1.8	(SF)	0	67	12.3	2	9	68	11.3
Lampsilis higginsii	Higgins eye pearlymussel	-	-	-	-	6	1.1	(WD)	1	6	1
Lampsilis teres	yellow sandshell	1	1.8	(SF)	1	3	0.6	(WD)	2	4	0.7
Leptodea fragilis	fragile papershell	3	5.4	(WD)	3	16	2.9	(WD)	16	19	3.2
Ligumia recta	black sandshell	0	0.0	(WD)	0	21	3.9	1	1	21	3.5
Obliquaria reflexa	threehorn wartyback	15	26.8	(WD)	15	53	9.7	1	52	68	11.3
Obovaria olivaria	hickorynut	-	-	-	-	0	0.0	1	0	0	0
Potamilus alatus	pink heelsplitter	-	-	-	-	14	2.6	1	4	14	2.3
Potamilus ohiensis	pink papershell	-	-	-	-	4	0.7	1	4	4	0.7
Toxolasma parvum	liliput	6	10.7	(WD)	6	3	0.6	(WD)	3	9	1.5
Truncilla donaciformis	fawnsfoot	3	5.4	3	3	8	1.5	(WD)	8	11	1.8
Truncilla truncata	deertoe	0	0.0	(WD)	0	0	0.0	1	0	0	0.0
	Subtotal	29	51.9	3	28	196	35.7	8	100	225	37.5
Pleurobemini											
Cyclonaias nodulata	wartyback	3	5.4	(WD)	3	3	0.6	(WD)	3	6	1
Cyclonaias pustulosa	pimpleback	1	1.8	(WD)	1	26	4.8	4	8	27	4.5
Fusconaia flava	Wabash pigtoe	0	0.0	(SF)	0	10	1.8	(WD)	5	10	1.7
Pleurobema sintoxia	round pigtoe	-	-	-	-	0	0.0	(SF)	0	0	0
Reginaia ebena	ebonyshell	-	-	-	-	0	0.0	(WD)	0	0	0
	Subtotal	4	7.2	0	4	39	7.0	4	16	43	7.2
Quadrulini											
Megalonaias nervosa	washboard	-	-	-	-	4	0.7	(WD)	0	4	0.7
Quadrula quadrula	mapleleaf	7	12.5	(WD)	5	52	9.6	1	30	59	9.8
Theliderma metanevra	monkeyface	-	-	-	-	0	0.0	(WD)	0	0	0
	Subtotal	7	12.5	0	5	56	10.3	1	30	63	10.5
Total		56	100	5	50	545	100	21	231	601	100
Total Species		16				27				27	
Species Richness (Live)		12				21				21	
Effort (min)						300					
Avg. CPUE (no./hour)						109.0					
Density ± 95% CI		1.82 ± 0.80									
Population Estimate		155,477 - 398,149									

[1] FD = fresh deadshell - numbers represent the summation of fresh deadshell, WD = weathered deadshell, SF = subfossil shell

Table 4. Mussel assemblage attributes in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Data Analysis/ Attributes		Quantitative	Qualitative	Total
Evenness (slope)		-0.261	-0.224	-
Diversity (1-D)		0.8578	0.7812	-
Rarefaction ES_x (95%CI)				
	x=10 individuals	6 (3-8)	6 (2-7)	-
	x=50 individuals	12 (10-14)	12 (7-15)	-
	x=100 individuals	14	15 (10-18)	-
	x=200 individuals	16	18 (14-20)	-
	x=300 individuals	18	19 (17-22)	-
No. Species				
	Amblemini	1	1	1
	Anodontini	2	4	4
	Lampsilini	6	10	10
	Pleurobema	2	3	3
	Quadrulini	1	2	2
	Total	12	20	20
Abundance[1]				
	Amblemini	12 (20.4)	231 (42.5)	243 (40.8)
	Anodontini	4 (7.2)	23 (4.2)	27 (4.5)
	Lampsilini	29 (51.9)	196 (35.9)	224 (37.3)
	Pleurobema	4 (7.2)	39 (7.0)	43 (7.2)
	Quadrulini	7 (12.5)	56 (10.3)	63 (10.5)
	Total	56	545	601
Fresh deadshell mortality (%)		5 (8.9)	21 (3.8)	26 (4.3)
No. unionids ≤ 5 years old		50	232	282
Recruitment (% ≤ 5 years old)		89.3	42.5	46.8
No. ≤ 30mm (%)		21 (37.5)	113 (20.8)	149 (24.8)
Zebra Mussel Infestation				
No. Zebra Mussel / unionid[1]				
	0	0	500 (91.7)	556 (92.5)
	1 - 10	0	45 (8.3)	45 (7.5)
	11 - 50	0	0 (0)	0 (0)
	> 50	0	0 (0)	0 (0)
% Zebra Mussel Coverage[1]				
	0	0	500 (91.7)	556 (92.5)
	1 - 10	0	34 (6.2)	34 (5.7)
	11 - 50	0	11 (2.0)	11 (1.8)
	51 - 100	0	0	-

[1]Relative abundance provided in parentheses (%)

Table 5. Quantitative mussel density and population estimates at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in Pool 14 of the Upper Mississippi River, Scott County, Iowa.

Species	No. live	Relative Abundance (%)	Density (no./m^2)	95% CI[1]	Population Estimate	95% CI[1]
Amblemini						
Amblema plicata	12	21.4	0.39	0.10 - 0.67	59,317	16,682 - 10,1952
Anodontini						
Pyganodon grandis	1	1.8	0.03	0 - 0.09	4,943	0 - 14,728
Utterbackia imbecillis	3	5.4	0.10	0 - 0.20	14,829	0 - 31,638
Lampsilini						
Lampsilis cardium	1	1.8	0.03	-0.0 - 0.09	4,943	0 - 14,728
Lampsilis teres	1	1.8	0.03	-0.0 - 0.09	4,943	0 - 14,728
Leptodea fragilis	3	5.4	0.10	-0.0 - 0.20	14,829	0 - 31,638
Obliquaria reflexa	15	26.8	0.49	0.17 - 0.79	74,146	26,851 - 121,442
Toxolasma parvum	6	10.7	0.20	0.01 - 0.37	29,659	2,381 - 56,936
Truncilla donaciformis	3	5.4	0.10	0 - 0.20	14,829	0 - 31,638
Pleurobemini						
Cyclonaias nodulata	3	5.4	0.10	-0.0 - 0.20	14,829	0 - 31,638
Cyclonaias pustulosa	1	1.8	0.03	-0.0 - 0.09	4,943	0 - 14,728
Quadrulini						
Quadrula quadrula	7	12.5	0.23	0.03 - 0.41	34,602	5,785 - 63,418
Total	56		1.82	1.02 - 2.61	276,813	155,477 - 398,149

[1]CI = Confidence Interval; Negative CI truncated to 0

Table 6. Age frequency distribution of live mussels collected during quantitative survey efforts at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in Pool 14 of the Upper Mississippi River, Scott County, Iowa.

	Age (external annuli estimation)																				
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	19	≥20	Total
Amblemini																					
Amblema plicata		2	1	2	5			1	1												12
Anodontini																					
Pyganodon grandis										1											1
Utterbackia imbecillis	1	2																			3
Lampsilini																					
Lampsilis cardium								1													1
Lampsilis teres	1																				**1**
Leptodea fragilis		2	1																		**3**
Obliquaria reflexa	1	1	2	8	3																**15**
Toxolasma parvum		1	1	2	1	1															6
Truncilla donaciformis				3																	3
Pleurobemini																					
Cyclonaias nodulata			1	2																	3
Cyclonaias pustulosa					1																1
Quadrulini																					
Quadrula quadrula				1	2	2	2														7
Grand Total	3	8	6	18	12	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0	56
Total %	5.4	14.3	10.7	32.1	21.4	5.4	3.6	3.6	1.8	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Table 7. Length frequency distribution of live mussels collected during quantitative survey efforts at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in Pool 14 of the Upper Mississippi River, Scott County, Iowa.

	length (mm, anterior to posterior)																												
Species	*0-5*	*5-10*	*10-15*	*15-20*	*20-25*	*25-30*	*30-35*	*35-40*	*40-45*	*45-50*	*50-55*	*55-60*	*60-65*	*65-70*	*70-75*	*75-80*	*80-85*	*85-90*	*90-95*	*95-100*	*100-105*	*105-110*	*110-115*	*115-120*	*120-125*	*125-130*	*130-135*	*135-140*	*Total*
Amblemini																													
Amblema plicata				2	1			2	3	1		1			1	1													12
Anodontini																													
Pyganodon grandis								0																		1			1
Utterbackia imbecillis				1				2																					3
Lampsilini																													
Lampsilis cardium																								1					1
Lampsilis teres			1																										1
Leptodea fragilis					2	1																							3
Obliquaria reflexa			1		1	1	3	6		2	1																		15
Toxolasma parvum		1	2	1	1	1																							6
Truncilla donaciformis				1	2																								3
Pleurobemini																													
Cyclonaias nodulata					1		1	1																					3
Cyclonaias pustulosa								1																					1
Quadrulini																													
Quadrula quadrula									1	2		1	2	1															7
Grand Total	0	1	4	5	8	3	4	12	4	5	1	2	2	1	1	1	0	0	0	0	0	0	0	1	0	1	0	0	56
Total %	0.0	1.8	7.1	8.9	14.3	5.4	7.1	21.4	7.1	8.9	1.8	3.6	3.6	1.8	1.8	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	1.8	0.0	0.0	100.0

Table 8. Unionid species collected in Steamboat Island Complex (SA1) and Steamboat Slough (SA2) during 2018 quantitative mussel survey efforts in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Species	Steamboat Island Complex[1]		Steamboat Slough		TOTAL	
	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)
Amblemini						
Amblema plicata	6	30.0	6	16.7	12	21.4
Subtotal	6	30.0	6	16.7	12	21.4
Anodontini				0.0		
Pyganodon grandis	1	5.0	0	0.0	1	1.8
Utterbackia imbecillis	1	5.0	2	5.6	3	5.4
Subtotal	2	10.0	2	5.6	4	7.1
Lampsilini		0.0		0.0		
Lampsilis cardium	0	0.0	1	2.8	1	1.8
Lampsilis teres	0	0.0	1	2.8	1	1.8
Leptodea fragilis	2	10.0	1	2.8	3	5.4
Obliquaria reflexa	4	20.0	11	30.6	15	26.8
Toxolasma parvum	4	20.0	2	5.6	6	10.7
Truncilla donaciformis	1	5.0	2	5.6	3	5.4
Subtotal	11	55.0	18	50.0	29	51.8
Pleurobemini		0.0		0.0		
Cyclonaias nodulata	0	0.0	3	8.3	3	5.4
Cyclonaias pustulosa	0	0.0	1	2.8	1	1.8
Subtotal	0	0.0	4	11.1	4	7.1
Quadrulini		0.0		0.0		
Quadrula quadrula	1	5.0	6	16.7	7	12.5
Subtotal	1	5.0	6	16.7	7	12.5
Total	20	100	36	100	56	100.0
Species Richness (Live)	8		11		12	
Density ± 95% CI	1.31 ±1.00		2.32 ±1.25		1.82 ±0.80	
Population Estimate	18,725 - 140,176		97,604 - 327,048		155,477 - 398,149	

[1]Steamboat Island Complex composed of 3 study areas: Head of Island, NE Berm, and Upper Lake Entrance

Table 9. Habitat attributes during mussel survey efforts in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Study Area	Effort Type	No. Samples	Depth (m) Ave.	Depth (m) Min.	Depth (m) Max.	Average % Substrate Composition Bedrock	Boulder	Cobble	Gravel	Sand	Silt	Clay
1 Steamboat Island Complex	Quantitative	61	2.9	0.6	6.1	0.0	0.0	0.0	0.0	76.2	2.4	21.3
2 Steamboat Slough	Quantitative	62	4.7	0.5	7.3	0.8	0.0	0.3	1.2	77.3	4.0	16.3
Total		123	3.8	0.5	7.3	0.4	0.0	0.2	0.6	76.8	3.3	18.8
2 Steamboat Slough	Qualitative	4	3	1.5	4.3	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3 Grant Slough	Qualitative	22	1.4	0.6	3	0.0	0.0	0.0	0.0	21.8	0.0	78.2
4 [1]MCI	Qualitative	12	3	2.1	4	4.2	0.0	0.0	0.0	75.0	0.0	20.8
5 [1]MCI Creation	Qualitative	22	2.3	1.2	5.2	0.0	0.0	0.2	11.1	57.0	10.5	21.6
Total		60	2.2	0.6	5.2	0.8	0.0	0.1	4.1	43.8	3.8	47.4

[1]MCI = Main Channel Island

Table 10. Power analysis of live mussels collected during quantitative survey efforts in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

		Pool 14 at Steamboat HREP
Sample Size (# quadrats)		123
Mean Mussel Density (individuals / m^2)		1.82
95% Confidence Interval		0.80
Standard Deviation		4.47
Precision[1]		43.8%
		No. of Samples
Precision Level[1]		
	15%	1,072
	20%	603
	25%	386

[1]Precision level = 95% CI of mean

Table 11. Unionid species collected during 2018 qualitative mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

	Qualitative									
Mussel Species	Steamboat Slough		Grant Slough		MCI		MCI Creation		TOTAL	
Scientific Name	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)	No. live	Abund. (%)
Amblemini										
Amblema plicata	20	41.7	174	55.2	5	25.0	32	19.8	231	42.4
Subtotal	20	41.7	174	55.2	5	25.0	32	19.8	231	42.4
Anodontini										
Arcidens confragosus	0	0.0	2	0.6	0	0.0	0	0.0	2	0.4
Lasmigona complanata	0	0.0	2	0.6	0	0.0	4	2.5	6	1.1
Pyganodon grandis	2	4.2	11	3.5	0	0.0	1	0.6	14	2.6
Utterbackia imbecillis	0	0.0	1	0.3	0	0.0	0	0.0	1	0.2
Subtotal	2	4.2	16	5.1	0	0.0	5	3.1	23	4.2
Lampsilini										
Ellipsaria lineolata	0	0.0	0	0.0	0	0.0	1	0.6	1	0.2
Lampsilis cardium	6	12.5	6	1.9	4	20.0	51	31.5	67	12.3
Lampsilis higginsii	0	0.0	0	0.0	0	0.0	6	3.7	6	1.1
Lampsilis teres	0	0.0	3	1.0	0	0.0	0	0.0	3	0.6
Leptodea fragilis	0	0.0	11	3.5	0	0.0	5	3.1	16	2.9
Ligumia recta	0	0.0	0	0.0	2	10.0	19	11.7	21	3.9
Obliquaria reflexa	9	18.8	26	8.3	5	25.0	13	8.0	53	9.7
Potamilus alatus	2	4.2	5	1.6	0	0.0	7	4.3	14	2.6
Potamilus ohiensis	0	0.0	3	1.0	0	0.0	1	0.6	4	0.7
Toxolasma parvum	0	0.0	2	0.6	0	0.0	1	0.6	3	0.6
Truncilla donaciformis	0	0.0	8	2.5	0	0.0	0	0.0	8	1.5
Subtotal	17	35.4	64	20.3	11	55.0	104	64.2	196	2.8
Pleurobemini										
Cyclonaias nodulata	1	2.1	1	0.3	0	0.0	1	0.6	3	0.6
Cyclonaias pustulosa	0	0.0	15	4.8	4	20.0	7	4.3	26	4.8
Fusconaia flava	0	0.0	6	1.9	0	0.0	4	2.5	10	1.8
Subtotal	1	2.1	22	7.0	4	20.0	12	7.4	39	7.2
Quadrulini										
Megalonaias nervosa	0	0.0	0	0.0	0	0.0	4	2.5	4	0.7
Quadrula quadrula	8	16.7	39	12.4	0	0.0	5	3.1	52	9.5
Subtotal	8	16.7	39	12.4	0	0.0	9	5.6	56	10.3
Total	48	100	315	100	20	100	162	100	545	100
Species Richness (live)	21		21		21		21		21	
Qualitative Effort (min)	20		110		60		110		300	
Avg. CPUE (no./hour)	144.0		171.8		20.0		88.4		109.0	
Min. CPUE (no./hour)	60.0		24.0		0.0		0.0		0.0	
Max. CPUE (no./hour)	348.0		516.0		120.0		300.0		516.0	

[1] MCI = Main Channel Island

Table 12. Length frequency distribution of live mussels collected during qualitative survey efforts at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in Pool 14 of the Upper Mississippi River, Scott County, Iowa.

	length (mm, anterior to posterior)																															
Species	*0-5*	*5-10*	*10-15*	*15-20*	*20-25*	*25-30*	*30-35*	*35-40*	*40-45*	*45-50*	*50-55*	*55-60*	*60-65*	*65-70*	*70-75*	*75-80*	*80-85*	*85-90*	*90-95*	*95-100*	*100-105*	*105-110*	*110-115*	*115-120*	*120-125*	*125-130*	*130-135*	*135-140*	*140-145*	*145-150*	*150-155*	*155-160*	*Total*
Amblemini																																	
Amblema plicata						4	7	7	7	5	8	10	12	12	20	21	25	20	34	15	10	5	4	3	1			1					231
Anodontini																																	
Arcidens confragosus																				1		1											2
Lasmigona complanata																										2		2			1	1	6
Pyganodon grandis													1												2	3	1	2		1	3	1	14
Utterbackia imbecillis												1																					1
Lampsilini																																	
Ellipsaria lineolata													1																				1
Lampsilis cardium										1				2			1	1	3	3	3	10	20	18	2	1	2						67
Lampsilis higginsii															2		1		3														6
Lampsilis teres					1															1			1										3
Leptodea fragilis			1									2	1	2		2				1	2	2	3										16
Ligumia recta																1						1	4	2	2	2	5	2	2				21
Obliquaria reflexa				1	1	3	16	13	10	6	3																						53
Potamilus alatus										1					3		1			2	1			1		1	1	3					14
Potamilus ohiensis											1				1						1	1											4
Toxolasma parvum				1	1	1																											3
Truncilla donaciformis		1	2	1	3	1																											8
Pleurobemini																																	
Cyclonaias nodulata						1			1	1																							3
Cyclonaias pustulosa					1		1	1	1	6	9	3	2	1		1																	26
Fusconaia flava						1	1	1	1		1	4	1																				10
Quadrulini																																	
Megalonaias nervosa																										2	1	1					4
Quadrula quadrula							2	2	2	6	7	3	3	8	7	4	3	4		1													52
Grand Total	0	1	3	3	7	11	27	24	22	26	29	23	21	25	33	29	31	25	40	24	17	20	32	24	7	11	10	11	2	1	4	2	545
Total %	0.0	0.2	0.6	0.6	1.3	2.0	5.0	4.4	4.0	4.8	5.3	4.2	3.9	4.6	6.1	5.3	5.7	4.6	7.3	4.4	3.1	3.7	5.9	4.4	1.3	2.0	1.8	2.0	0.4	0.2	0.7	0.4	100.0

Table 13. Age frequency distribution of live mussels collected during qualitative survey efforts in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

	Age (external annuli estimation)																					
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	>20	Total
Amblemini																						
Amblema plicata			9	19	26	30	29	32	36	26	14	5	3	2								231
Anodontini																						
Arcidens confragosus								2														2
Lasmigona complanata							1	1	1	1	1	1										6
Pyganodon grandis			1				1	1	3	3	2	2	1									14
Utterbackia imbecillis			1																			1
Lampsilini																						
Ellipsaria lineolata							1															1
Lampsilis cardium				2	1	6	7	6	9	14	6	10	4		2							67
Lampsilis higginsii						1		1		1	1	1	1									6
Lampsilis teres	1				1		1															3
Leptodea fragilis	1		3	8	3	1																16
Ligumia recta						1		6	3	3	2	2	1	1	1	1						21
Obliquaria reflexa		1	14	21	14	2					1											53
Potamilus alatus				3	1		1	1	5	2			1									14
Potamilus ohiensis			1		1	2																4
Toxolasma parvum	1	1	2	3	1																	8
Truncilla donaciformis				2		1																3
Pleurobemini																						
Cyclonaias nodulata				2		1																3
Cyclonaias pustulosa				3	3	2	6		5	3	2	2										26
Fusconaia flava			2	2	1		2	2	1													10
Quadrulini																						
Megalonaias nervosa													1	1	1	1						4
Quadrula quadrula			3	7	11	9	12	4	2	2	2											52
Grand Total	3	2	36	72	63	56	61	56	65	55	31	23	12	4	4	2	0	0	0	0	0	545
Total %	0.6	0.4	6.6	13.2	11.6	10.3	11.2	10.3	11.9	10.1	5.7	4.2	2.2	0.7	0.7	0.4	0.0	0.0	0.0	0.0	0.0	100.0

Table 14. Federally endangered mussels collected in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Study Area[1]		Sample ID	Species	New Tag(s)[2]	Sex	Age (years)	Length (mm)	Substrate Composition	Depth (m)	No. Zebra Mussels
5	MCI Creation	20180927153010	*Lampsilis higginsii*	0500-0501	F	7	73.6	50% clay 50% gravel	2.7	0
5	MCI Creation	20180927153010	*Lampsilis higginsii*	0502-0503	M	11	90.4	50% clay 50% gravel	2.7	0
5	MCI Creation	20180927153011	*Lampsilis higginsii*	0504-0505	F	9	84.5	50% clay 50% sand	2.4	0
5	MCI Creation	20180927153018	*Lampsilis higginsii*	0506-0507	F	12	92.0	30% clay 10% fines 60% sand	2.1	0
5	MCI Creation	20180924152030	*Lampsilis higginsii*	A18	M	10	93.5	25% clay 25% sand 50% gravel	3.0	0
5	MCI Creation	20180924152024	*Lampsilis higginsii*	B18	M	5	73.4	100% sand	1.5	0

[1]MCI = Main Channel Island

[2]Orange tags

Steamboat Island HREP
Mussel Survey Results Discussion
Conference Call
November 15, 2018

Attendees: Sharonne Baylor (USFWS), Ed Britton (USFWS), Nate Williams (USFWS), Sara Schmuecker (USFWS), Tyler Porter (USFWS), Vanessa Armentrout (USFWS) and Scott Gritters (IA DNR)
*Jenny Skufka (IL DNR) provided input prior to call.

The team worked through the proposed Project features, one by one, to assess potential freshwater mussel resources that may be impacted as identified by the 2018 mussel survey, avoidance and minimization measures, alternatives, and conservation measures. As detailed in the notes below, the team emphasizes the need to work through all potential avoidance and minimization measures to reduce potential mussel resource impacts related to Project feature footprints, access routes, etc. prior to addressing permitting and take. Based on the 2018 mussel survey results, the team recommends all proposed Project features continue to be carried forward for consideration.

<u>SE Islands</u>

- 2018 Mussel Survey Results
    - Island closest to main channel: Mussel resources surrounding this island were found to be sparse along the main channel border (NW side), with freshwater mussel densities increasing to 1-50 mussels/hour CPUE along the east side of the island, bordering the Cordova EHA.
    - Cordova EHA Island: Mussel densities were found to be fairly consistent on all sides of the island, varying from 0 to 350 mussels/hour CPUE. Although this island is located inside of the EHA mussel bed and construction may result in initial mussel impacts, the team feels that the long-term benefits of increased flow diversity, increased potential mussel habitat, and increased fish habitat/attraction, particularly smallmouth bass (Higgin's-eye host), outweigh removing the feature from Project consideration.
- Avoidance and Minimization Measures
    - This mussel survey was originally designed with only spot surveys surrounding the SE islands to determine whether or not a mussel resource is present, with the intent of completing additional quadrat survey work should these features remain in consideration for the Project.
        - Illinois DNR:
            - If work is planned in areas where Illinois DNR listed species are present, an incidental take permit will be needed.
            - IL DNR is currently working to revise their mussel survey requirements. Jenny will provide additional information, when available.
        - USFWS:
            - Additional survey work may be necessary in areas on the east side of the island closest to the main channel, within the Cordova EHA, or access dredging areas that were not previously surveyed if they are

carried forward as part of the Project design. However, based on the long-term EHA survey data and information from the 2018 mussel survey, we may be able to calculate a take estimate that could be used to develop the BA and BO (assuming TE presence) without additional survey work needed.

        - A BA/BO will be necessary for any work conducted within the Cordova EHA.
    - Consider concentrating the Cordova mussel cleaning around the SE islands next summer (2019) to better delineate locations of mussel resources and identify potential project footprint and access locations where impacts to mussel resources may be avoided/reduced.
    - Reduce the use of the Cordova boat ramp for Project construction when outside of a high water event. Limit use to small crafts. Other large boats and barges should launch/stage from another site.
- Alternatives Considered
    - Consider phasing construction, with this portion of the Project completed last to allow for any additional survey, permitting, or other necessary measures. Process-wise would this be feasible?
- Conservation Measures
    - Relocate mussels from areas of potential impact prior to construction of the SE islands, particularly the Cordova EHA Island.
    - Consider integrating the benched mussel habitat substrate design (like Beaver Island HREP) into the rock armoring design to provide additional mussel and fish benefits.

<u>Grant Slough</u>

- 2018 Mussel Survey Results
    - Mussel resources throughout the length of Grant Slough were documented to be fairly consistent on both sides of the slough with around 51 – 350 mussels/hour CPUE in the majority of the survey areas. The upstream-most survey sites within Grant Slough were documented to have a CPUE of 351-516 mussels/hour, near the GS #4 and 5 dredged material placement areas.
- Avoidance and Minimization Measures
    - Additional mussel surveys may facilitate design of the access dredging route through Grant Slough to minimize and avoid impacts to mussel resources within the slough. Deconstruct the actions in Grant Slough once they are near-final and plan accordingly for mussel avoidance and minimization.
- Alternatives Considered
    - Consider accessing placement areas GS #4 and 5 from Steamboat Slough. *Reference Scott's timed search surveys for mussel resources on the Steamboat Slough side of GS #4 and 5. USFWS and IADNR are in agreement with tree clearing to access the placement sites if done between October 1 and March 31.
- Conservation Measures
    - Consider relocation of mussels from proposed dredge cut footprints.

Lower Steamboat Slough

- 2018 Mussel Survey Results
  - Overall, there appears to be a fairly low mussel abundance within lower Steamboat Slough with a CPUE of 51-150 mussel/hour. Of the 62 quads that were completed, 44 were identified to have no mussels, 11 quads had 1 mussel per $0.25m^2$, 4 quads had 2-4 mussel per $0.25m^2$, and 3 quads had 5-6 mussel per $0.25m^2$.
- Avoidance and Minimization Measures
  - None discussed
- Alternatives Considered
  - None discussed
- Conservation Measures
  - Consider relocating mussels from feature footprint.

Head of Island

- 2018 Mussel Survey Results
  - Overall, there appears to be a fairly low mussel abundance at the head of Steamboat Island with a CPUE of 2-4 mussels/hour. Of the 36 quadrats, 34 had 0 mussels and 2 had 2-4 mussel per $0.25m^2$.
- Avoidance and Minimization Measures
  - None discussed
- Alternatives Considered
  - None discussed
- Conservation Measures
  - Consider integrating the benched mussel habitat substrate design (like Beaver Island HREP) into the rock armoring design.
  - Consider relocating mussels from feature footprint.

NE Berm and Upper Lake Entrance

- 2018 Mussel Survey Results
  - NE Berm: Only one mussel was identified from the 12 quadrats collected from the NE Berm location.
  - Upper Lake Entrance: 13 quadrats were collected, ranging from 0 to 6 mussel per $0.25m^2$. Mussel densities appear to increase as you move downstream. CPUE ranged from 2-6 mussels/hour.
- Avoidance and Minimization Measures
  - None discussed
- Alternatives Considered
  - None discussed
- Conservation Measures
  - Consider relocating mussels from areas of potential impact.

From:	Herzog, Kathryn M [redacted]
To:	Michl, Davi E [redacted]
Subject:	FW: [Non-DoD Source] Re: [EXTERNAL] Existing conditions info needed
Date:	Monday, January 28, 2019 12:27:55 PM
Attachments:	Steamboat Island Mussel Records_RM 503 to 506.pdf

Here is some background on where I am for Steamboat. Basically still waiting on #6 for the Eastern Massasauga from FWS.

-----Original Message-----
From: Schmuecker, Sara [mailto:sara_s[redacted]
Sent: Tuesday, November 20, 2018 11:05 AM
To: [redacted]
Subject: [Non-DoD Source] Re: [EXTERNAL] Existing conditions info needed

Hi Kat,

3. Scott and the IA DNR completed some searches - I'm not sure what year or their results, but Scott would be able to provide further information. I have attached a map of their survey sites. I'm not certain what interagency surveys you are referencing, but I have attached a PDF file with all the records we have for the Steamboat Island/ Cordova EHA area.
4. There is a record in the 2015 Natural Resource Inventory provided by Jeremy Tiemann (IL Natural History Survey), showing that 1 live sheepnose was identified near RM 503.2 (41.6835, -90.3178; Cordova boat ramp) during a survey conducted in August 2006 (see attached PDF). I am not aware of any spectaclecase records near the project area.
6. More soon once we confirm potential habitat boundaries with Terry VanDeWalle.

- Sara

Sara Schmuecker
U.S. Fish and Wildlife Service
Illinois - Iowa Field Office
[redacted] o [redacted]
[redacted]

On Tue, Nov 20, 2018 at 9:07 AM Herzog, Kathryn M [redacted] (US) [redacted] wrote:

Hello all,

We, the Corps, have been working on Chapters 1-4 for Steamboat HREP. I am working on Chapter 2, Existing Conditions, and I have some things that need your input:

1. FWS Management/Public use of this area.
2. Aerial waterfowl surveys for this area.
3. I have the following mussel survey information: Recent 2018 survey, surveys conducted for Exelon (last surveyed in 2017), and additional surveys by an interagency effort in 2012 and 2017. The 2012 and 2017 ones come from the Natural Resource Inventory database, were these interagency efforts or conducted by another entity? Is

there any more besides the listed?

4. With the past mussel surveys, have spectaclecase and/or sheepnose been encountered in this area?
5. Has FWS/IA DNR conducted any surveys for aquatic vegetation that we can put into the report?
6. There was an occurrence of the listed Eastern Massasauga in the Natural Resource Inventory database. It was outside of the project area, but adjacent. Will FWS require surveys for this?

I appreciate your help in getting this compiled. Feel free to reach out if you have any questions.

Thanks,
Kat


Exelon
Egeneration
506
Island No. 299
505
Island No. 300
504
Mississippi River
503
Cordova

Steamboat Island and Cordova EHA Mussel Records

Upper River Mile	Lower River Mile	Descending Bank	Description	Reference	Revision Year
506.0	505.0	Right	mussel bed	T. Boland - IADNR	2000
505.5	505.0	Left	mussel bed - species include Higgins eye; essential habitat for Higgins eye	Cawley 1996; U.S. Fish and Wildlife Service 1983 - cited by U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers 1984	1984
504.5		Right	mussel collection - 14 species including rock pocketbook, Higgins eye, washboard and butterfly	Perry 1979; Miller and Payne 1994; Cawley 1996	2000
504.0		Right	Steamboat Slough: mussel collection - 25 species, including Higgins eye, were collected in 1980	Cawley 1996	2000
505.0	503.0	Left	located near Cordova, IL just upstream of the boat ramp; 20+ extant species including black sandshell, washboard, hickorynut, butterfly, wartyback, creeper and Higgins eye; essential habitat for Higgins eye; numerous collections	USFWS and USACE 1984; Perry 1979; Miller et al. 1990; Miller and Payne 1991 and 1994; M. Havlik - Malacological Consultants; J. Tiemann - Illinois Natural History Survey (INHS); INHS Mollusk Collection (Rock Island #6)	2015
506.2	505.0	Right	Steamboat Slough: mussel bed along right descending bank wingdams	J. Haas - Exelon Quad Cities Nuclear Station	2015
503.0	<null>	Left	mussel survey (2007) identified 5 species including black sandshell and washboard	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015
503.2	<null>	Left	surveys between 2005-2008 identified 26 mussel species including mucket, rock pocketbook, butterfly, Higgins eye, yellow/slough	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015

Upper River Mile	Lower River Mile	Descending Bank	Description	Reference	Revision Year
			sandshell, black sandshell, washboard, sheepnose, wartyback, monkeyface, strange floater, and fawnsfoot		
503.6	<null>	Left	surveys between 2000-2012 identified 29 mussel species including mucket, rock pocketbook, butterfly, spike, ebony shell, Higgins eye, yellow/slough sandshell, black sandshell, washboard, round pigtoe, strange floater, pistolgrip, etc	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015
504.0	<null>	Left	mussel survey (1999) identified 16 mussel species including mucket, rock pocketbook, black sandshell, washboard, and monkeyface	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015
504.0	<null>	Left	survey (2012) identified 16 species including butterfly, black sandshell, washboard, and fawnsfoot	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015
504.6	<null>	Left	survey (1999) identified 12 mussel species including rock pocketbook, black sandshell and washboard	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015
504.5	<null>	Left	survey (1999) identified 20 mussel species including rock pocketbook, butterfly, Higgins eye, yellow/slough sandshell, black sandshell, washboard, wartyback, and strange floater	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015
505.0	<null>	Left	survey (2010) identified 21 species including mucket, rock pocketbook, Higgins	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015

Upper River Mile	Lower River Mile	Descending Bank	Description	Reference	Revision Year
			eye, yellow/slough sandshell, black sandshell, washboard, wartyback, and strange floater		
505.6	<null>	Left	survey (1999) identified 12 species including wartyback	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015
506.0	<null>	Right	survey (2012) identified 11 species including yellow/slough sandshell, wartyback, and fawnsfoot	J. Tiemann - Illinois Natural History Survey and Museum Mollusk Collection Records	2015
505.0	<null>	Left	Cordova, IL: survey (2001) identifed 13 species including rock pocketbook, Higgin's-eye, and black sandshell	U.S. Army Corps of Engineers - Freshwater Mussel Database	2015
503.1	<null>	Left	Higgin's-eye identified in 1980	Iowa Natural Areas Inventory (Accessed October 19, 2015)	2015
504.0	<null>	Left	Higgin's-eye identified in 2004	Iowa Natural Areas Inventory (Accessed October 19, 2015)	2015
504.4	<null>	Left	Higgin's-eye identified in 1980	Iowa Natural Areas Inventory (Accessed October 19, 2015)	2015
505.5	503.0	Left	mussel bed, 24 species including yellow sandshell, black sandshell, butterfly, higgins eye, monkeyface identified in 2014, 10 species identified in 2000, 21 species identified in 2010.	J. Jordan - U.S. Army Corps of Engineers	2015
503.6	<null>	?	Mussel survey completed by Helms (2000); 21 species identified	S. Gritters - IADNR, Unpublished Mussel Database	2015
504.0	<null>	?	Mussel survey completed by Ecological Specialists, Inc.	S. Gritters - IADNR, Unpublished Mussel	2015

Upper River Mile	Lower River Mile	Descending Bank	Description	Reference	Revision Year
			(2002, 2004, 2012); 19 species identified	Database	
503.0	<null>	?	survey (2003, Harding/ESE) identified 9 species	S. Gritters - IADNR, Unpublished Mussel Database	2015
505.6	<null>	Right	Mussel survey completed in Steamboat Slough by Ecological Specialists, Inc. (2012); 25 species identified	S. Gritters - IADNR, Unpublished Mussel Database	2015
503.2	<null>	Left	Mussel survey completed at Small Island by IADNR (2012); 4 species identified including threeridge, plain pocketbook, pimpleback, and deertoe	S. Gritters - IADNR, Unpublished Mussel Database	2015

From:	Schmuecker, Sara
To:	Herzog, Kathryn M [redacted]
Cc:	Skufca, Jenny
Subject:	[Non-DoD Source] Steamboat Island Mussel Considerations
Date:	Tuesday, December 4, 2018 1:31:10 PM

Hi Kat -

Below are the combined FWS and IL DNR requirements for take permits associated with the SE islands features with respect to the presence of Higgins eye, black sandshell, and the Cordova EHA. Please Note: This is a collective list with not all of these items being required by both Agencies. We tried to encompass all potential island feature designs in the below conservation measures; however, various actions and impacts that may be identified as the project features are further refined may require additional assessment.

Channel Island = the SE island closest to the channel.

EHA Island = the SE island located within the Cordova EHA.

- **Work-zone Restrictions:** Restrict work to the minimum necessary area. Identify Authorized Work Areas for project contractors to prevent construction activities from occurring in identified Environmentally Sensitive Areas.
- **Surveys:** Current surveys are sufficient to prepare a FWS BA/BO and IL DNR ITP. No additional survey is needed. However, we are currently assuming the presence of Higgins eye at the Channel Island due to its proximity to the Cordova EHA and low resolution of survey completed. If the EHA Island is removed from the project, additional survey work at the Channel Island may negate the need for BA/BO preparation, pending results. As previously discussed by the PDT, the Cordova mussel cleaning effort may be able to meet additional survey requirements, provided the draft Upper Mississippi River Mussel Survey Guidance is followed, which would require divers in water depths that are not possible to pollywog and an appropriate level of survey effort.
- **Relocation:** With the purpose of this project being habitat restoration, we would like to see mussels relocated from all areas where mussel resources were identified during the survey effort as a minimization measure. However, at a minimum, mussels should be relocated from all areas of high density (10 mussels or greater) as identified during the 2018 mussel survey and presented on the Steamboat Island HREP - Constraints map.
- **Post-Construction Monitoring:** Post-construction monitoring would be required to test the assumptions of affects analyses used to determine take estimates. The scale and duration of the monitoring will depend on the final feature design, associated impacts, and whether one or both islands are carried forward in project planning. Monitoring of the EHA Island may include monitoring around the project footprint to assess EHA habitat impacts. Survival monitoring of relocated mussels may be

incorporated into ongoing monitoring associated with the Cordova EHA (every 4-years).

- **Zebra Mussels:** Barges and watercraft used for construction activities should be inspected for the presence of zebra mussels prior to launching to reduce potential infestation impacts to the EHA.

- **Cordova boat ramp:** Use of the Cordova boat ramp should be limited to small watercraft. No barges or other equipment requiring dredging or sediment disturbance within the Cordova EHA should launch from or utilize the ramp.

As always, please feel free to reach out with any questions.

Sara Schmuecker
U.S. Fish and Wildlife Service
Illinois - Iowa Field Office
[redacted]

Pesi 1027.05

FINAL REPORT
MONITORING OF
NATIVE AND NON-INDIGENOUS MUSSEL SPECIES
IN THE UPPER MISSISSIPPI RIVER AT
TWO HIGGINS EYE PEARLYMUSSEL (*LAMPSILIS HIGGINSII*)
ESSENTIAL HABITAT AREAS,
CORDOVA, ILLINOIS (POOL 14) AND BUFFALO, IOWA (POOL 16)

24 January 2019

Prepared for:

U.S. Army Corps of Engineers – Rock Island District
1500 Rock Island Drive
Rock Island, Illinois 61201

Contract No. W912EK-16-D-0010

Prepared by:

Environmental Solutions & Innovations, Inc.

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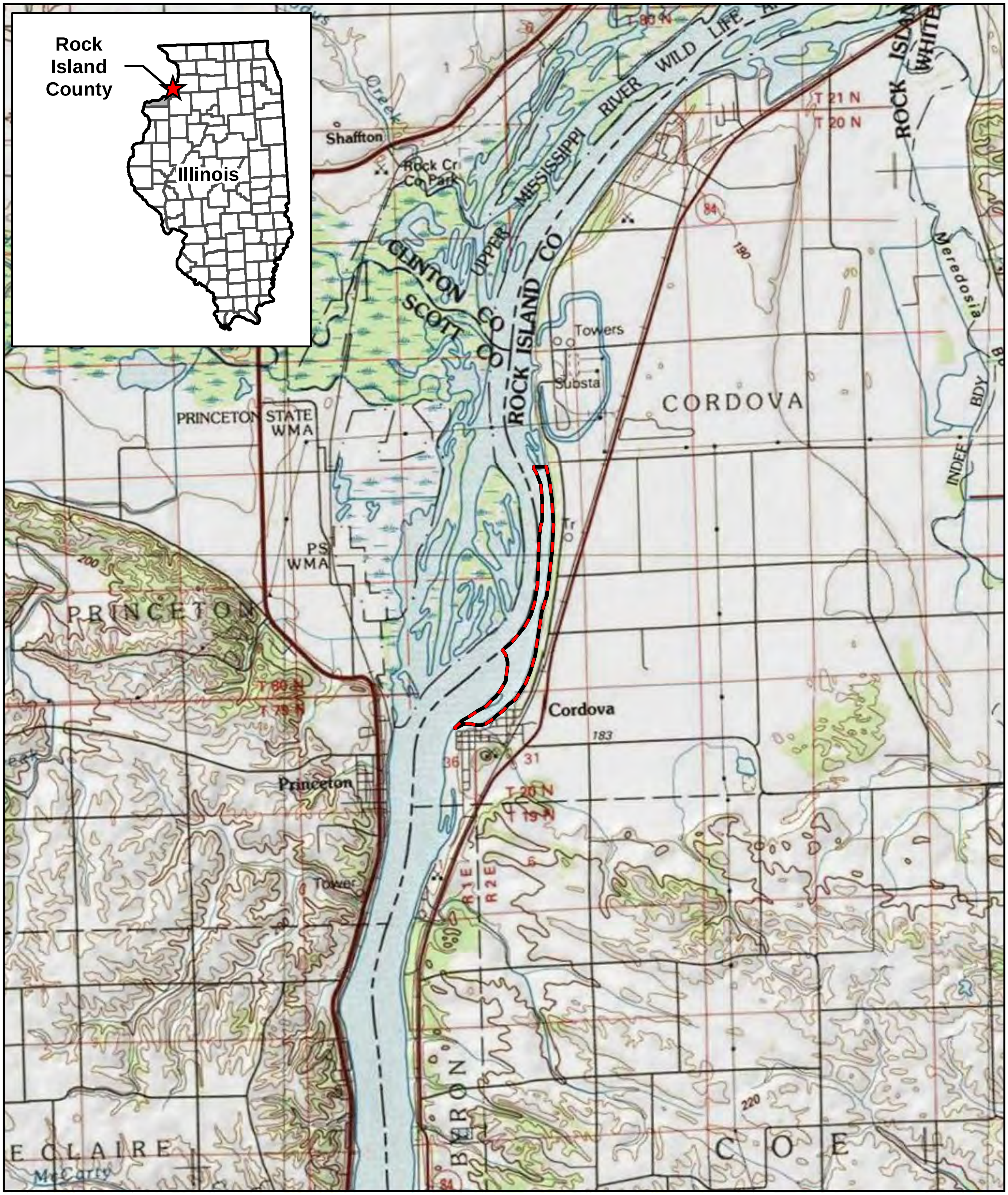
FIGURES



Essential Habitat Area (EHA)

N
W E
S

Figure 1. Location of freshwater mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

Project No. 1027.05	990 0 990 1,980 Meters Base Map: ESRI "USGS Topographic Map"	ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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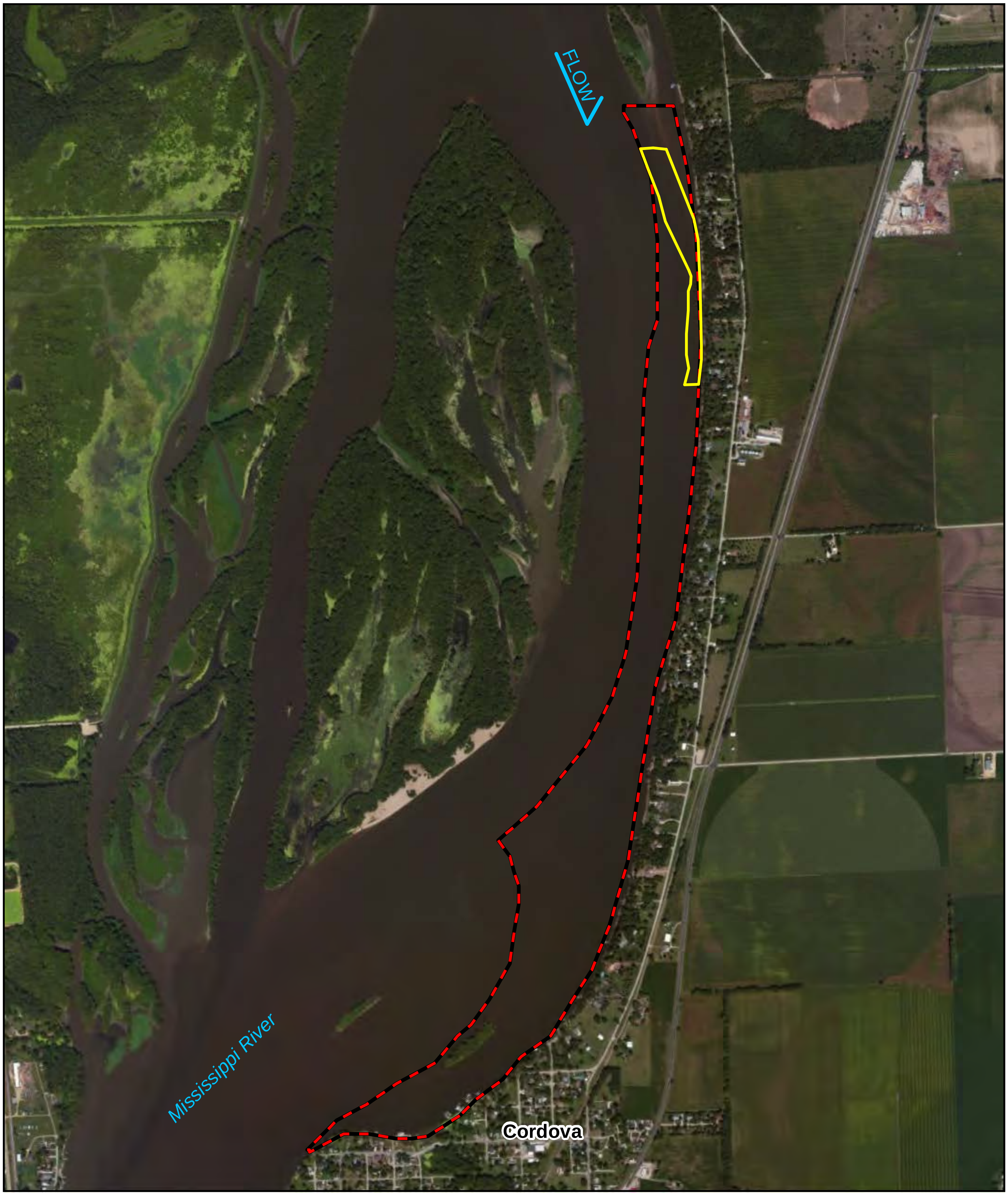

Long Term Monitoring Site (LTMS)   Essential Habitat Area (EHA)

Figure 3. Freshwater mussel survey extent in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.

N W E S

Project No. 1027.05

250 0 250 500 Meters

Base Map: ESRI "World_Imagery (Clarity)"

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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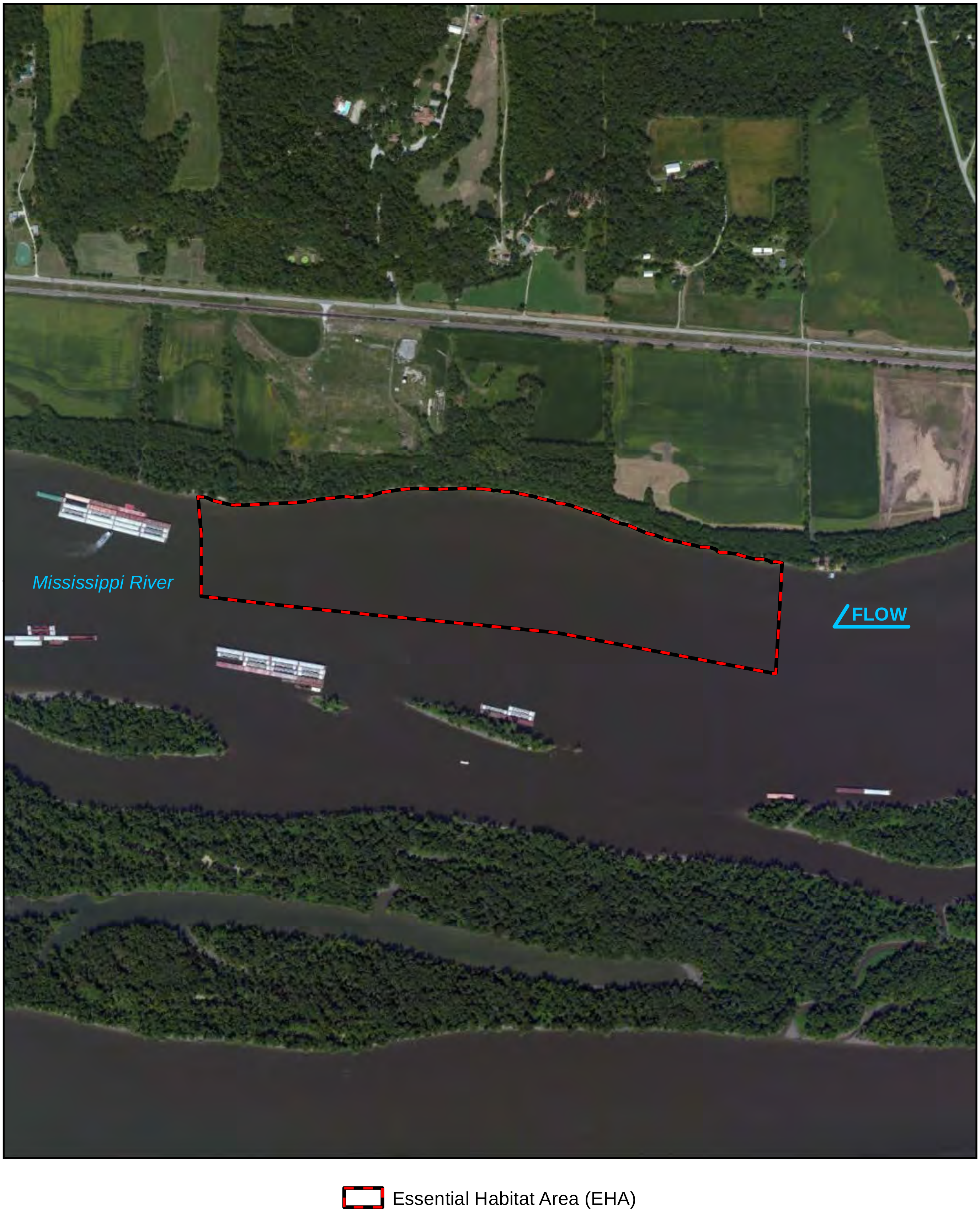

Figure 4. Freshwater mussel survey extent in Pool 16 at the Buffalo Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Scott County, Iowa.

Project No. 1027.05

Base Map: ESRI "World_Imagery (Clarity)"

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

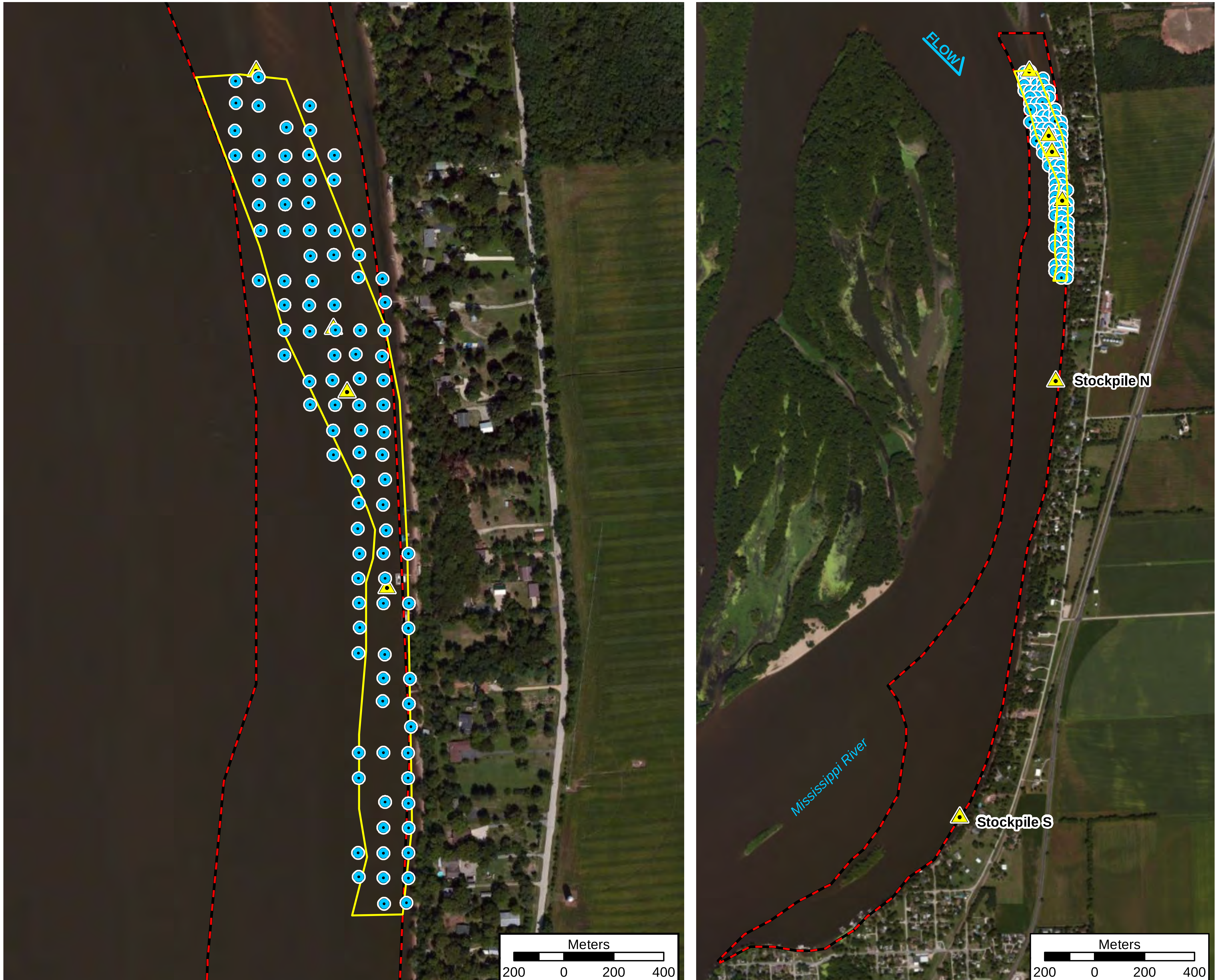

Figure 5. Quantitative and qualitative sample locations in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.

Qualitative Sampling Location (6)
Quantitative Sampling Location (100)
Long Term Monitoring Site (LTMS)
Essential Habitat Area (EHA)

N
W E
S

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 1/18/2019

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Figure 6. Quantitative and qualitative sample locations in Pool 16 at the Buffalo Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Scott County, Iowa.

Quantitative Sampling Location (150)
Qualitative Sampling Location (5)
Essential Habitat Area (EHA)

N
W E
S

Meters
100 0 100 200

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 11/28/2018

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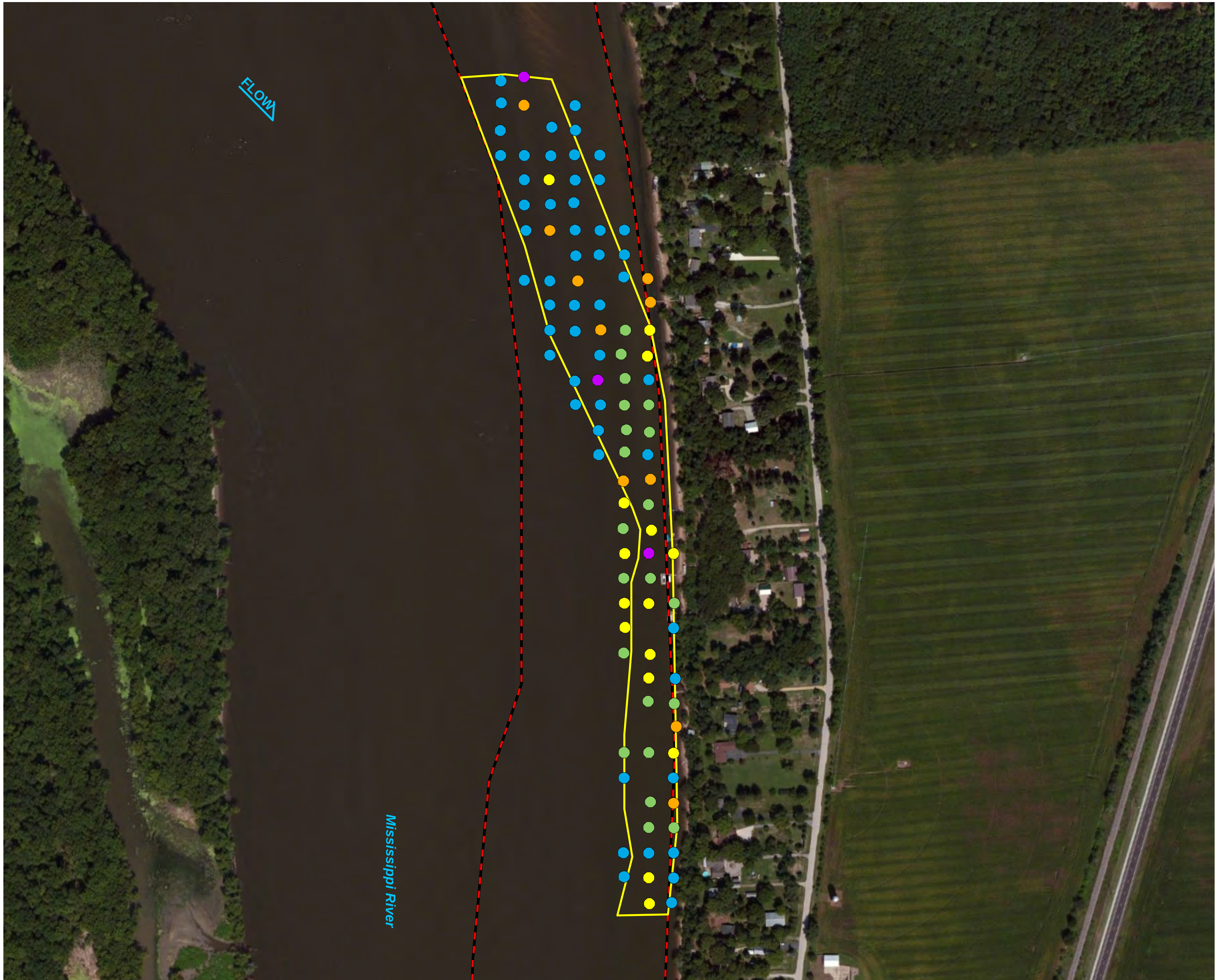
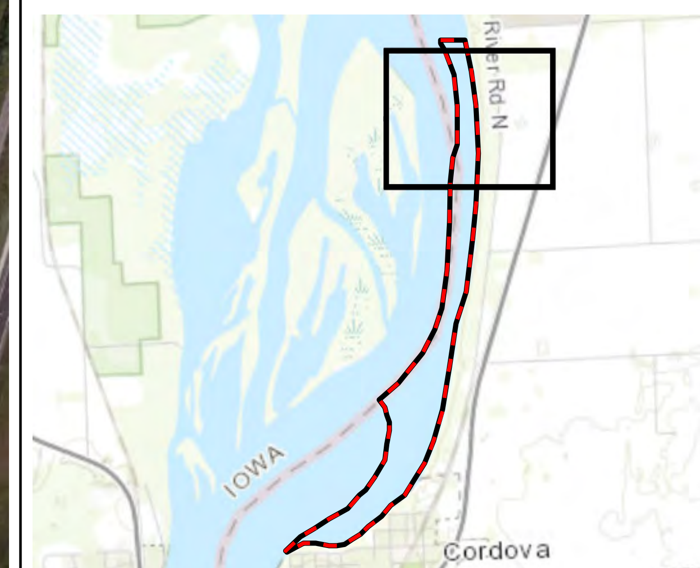
Figure 7. Quantitative mussel abundance for freshwater mussel surveys at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.



Mussel Abundance (no./0.25m²)

- 0 - 1 (51)
- 2 - 3 (21)
- 4 - 5 (15)
- 6 - 9 (10)
- 10 - 12 (3)
- Long Term Monitoring Site (LTMS)
- Essential Habitat Area (EHA)



N
W E
S

Meters
50 0 50 100

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 1/23/2019

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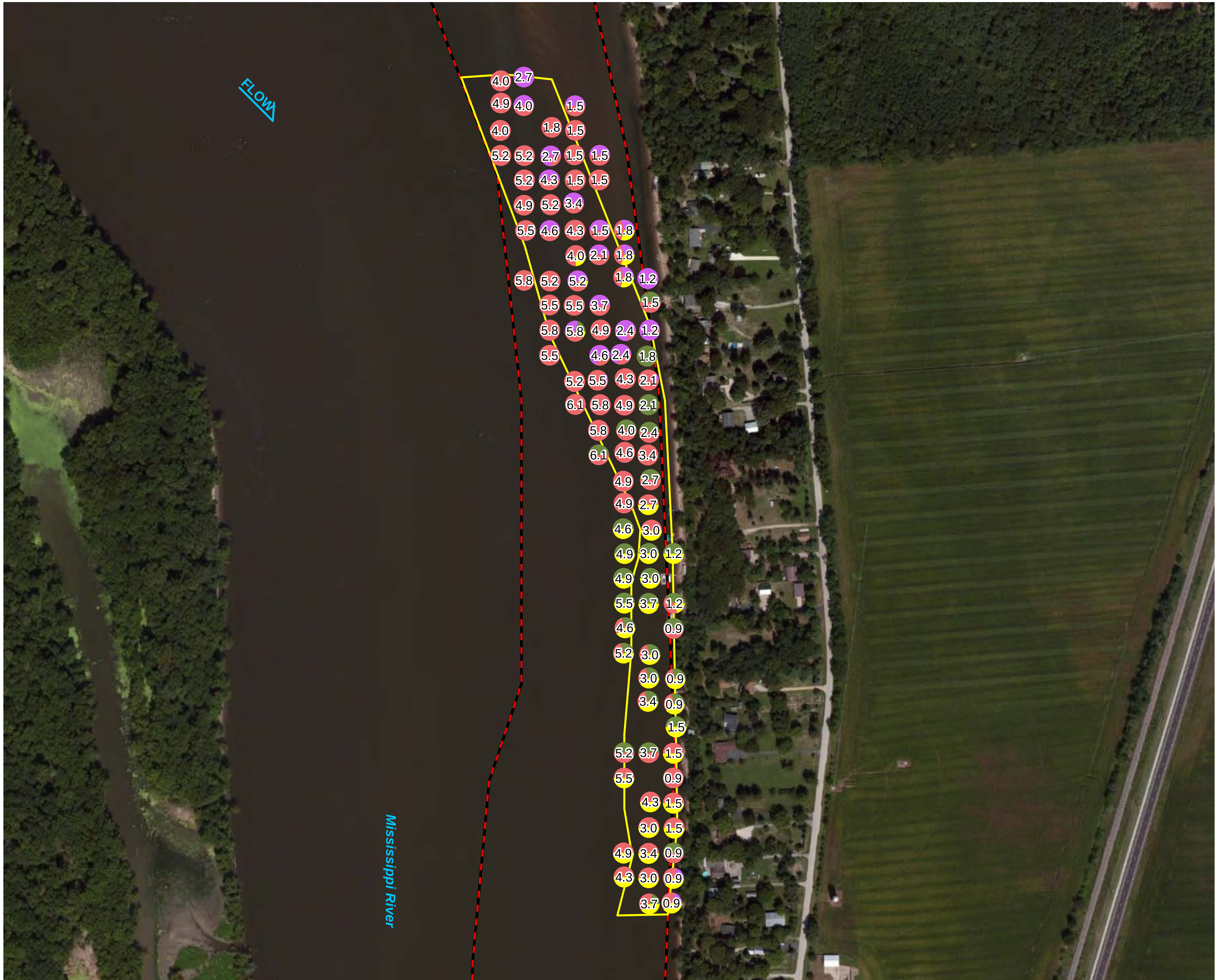
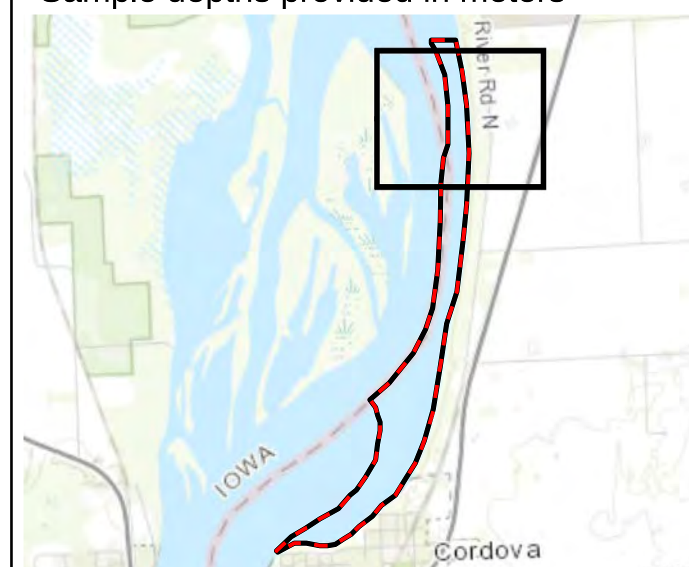


Figure 8. Quantitative sample depth and substrate composition for freshwater mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.

Quantitative Sampling Location

- Clay
- Fines
- Sand
- Gravel
- Long Term Monitoring Site (LTMS)
- Essential Habitat Area (EHA)

Sample depths provided in meters



N
W E
S

Meters
50 0 50 100

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 1/18/2019

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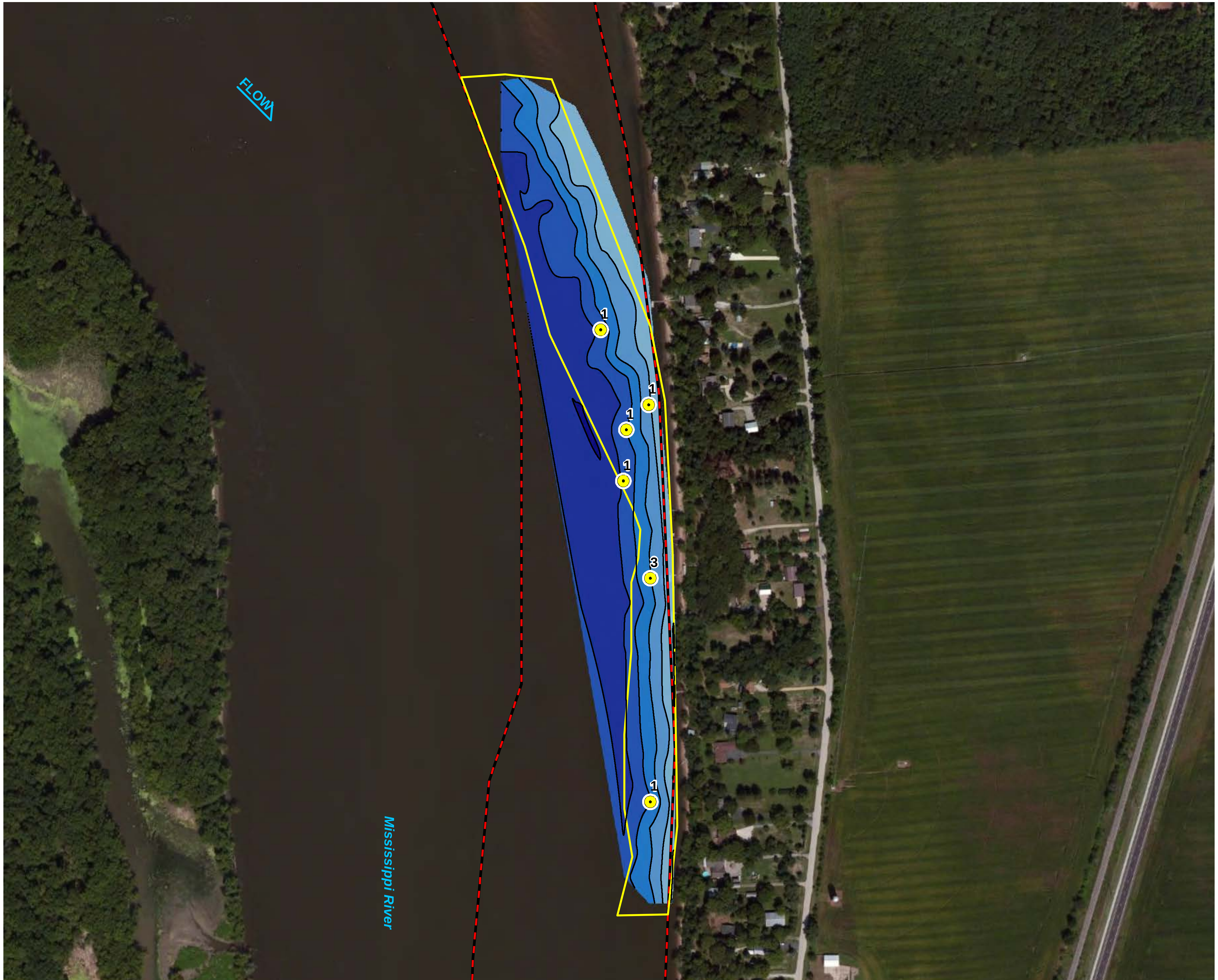
Figure 9. Bathymetric profile and occurrence of federally endangered mussels in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.



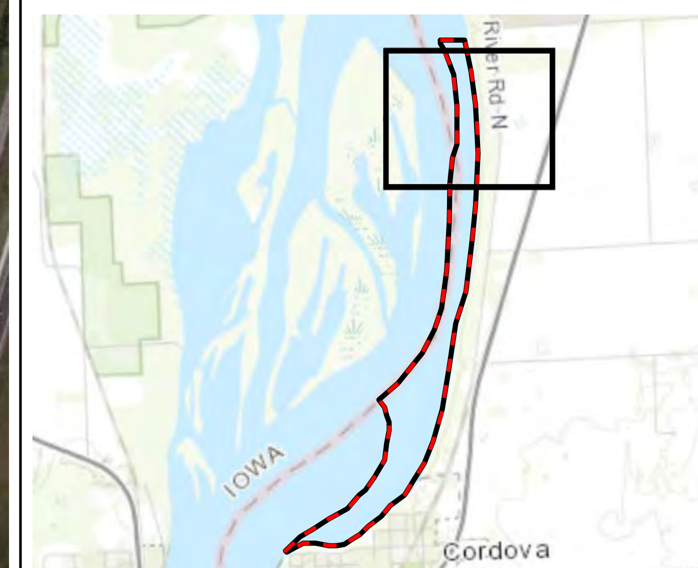
Higgins' eye pearly mussel location (6)

Long Term Monitoring Site (LTMS)

Essential Habitat Area (EHA)

Bathymetry data (depth in meters)

- 0.92 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0
- 6.1 - 6.1



N W E S

Meters

50 0 50 100

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 1/18/2019

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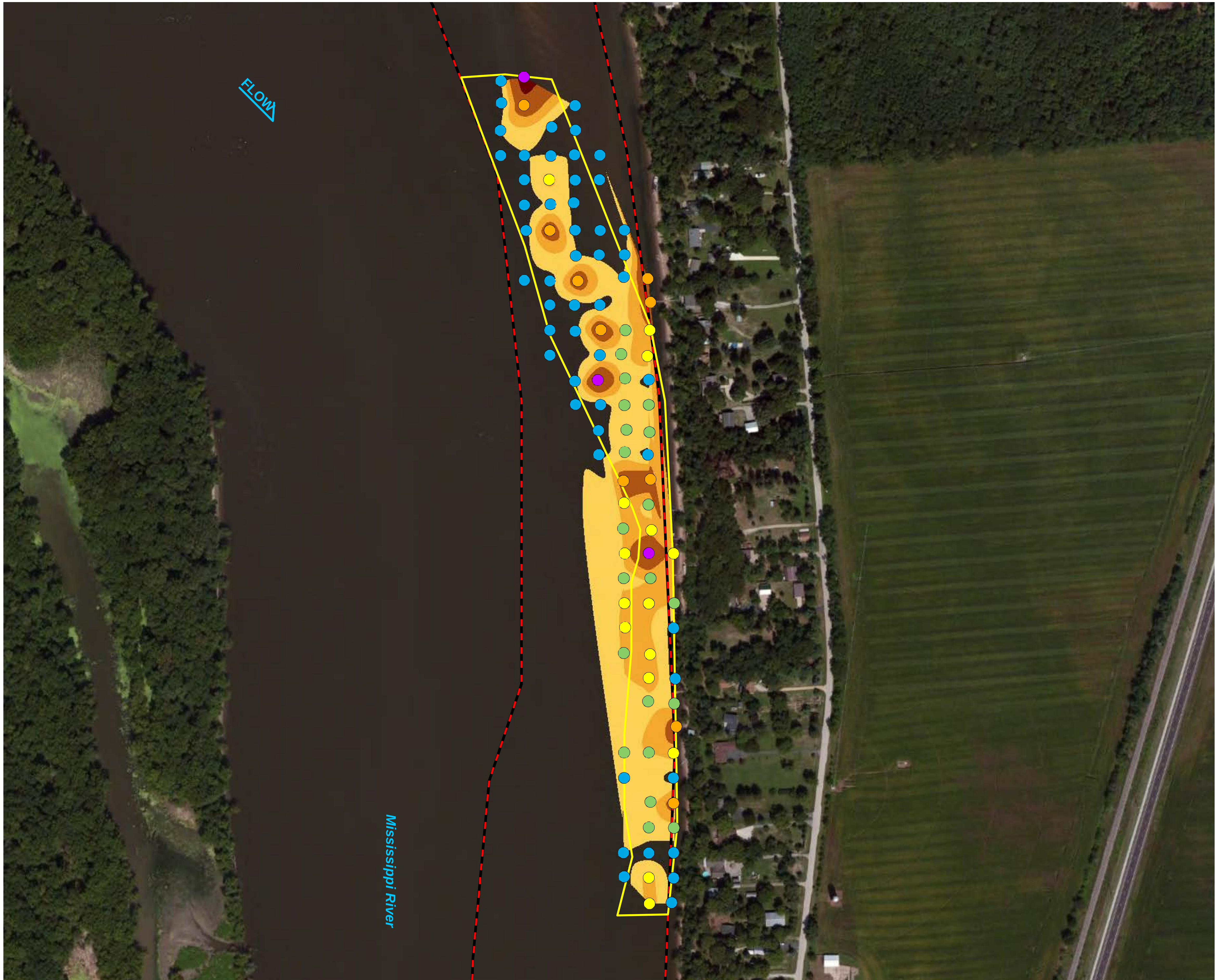


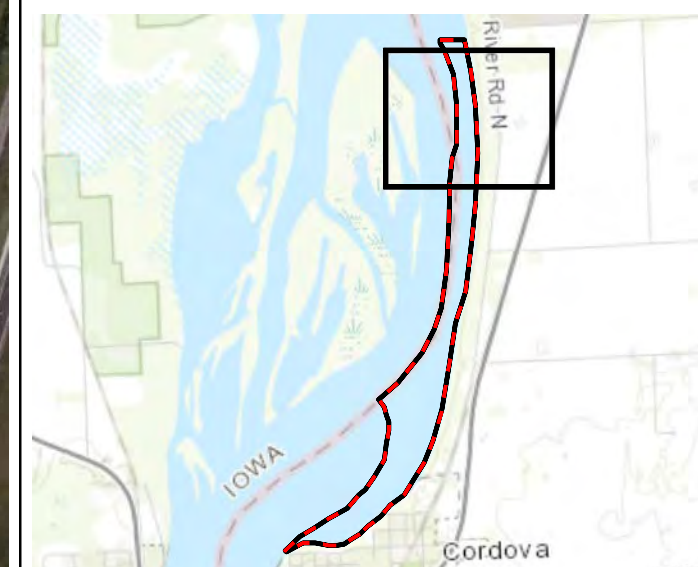
Figure 10. Extrapolated mussel densities in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.

Quantitative Sampling Location

- 0 - 1 (51)
- 2 - 3 (21)
- 4 - 5 (15)
- 6 - 9 (10)
- 10 - 12 (3)

Extrapolated Mussel Density (no./0.25m²)

- 0 - 1
- 2 - 3
- 4 - 5
- 6 - 9
- 10 - 12
- Long Term Monitoring Site (LTMS)
- Essential Habitat Area (EHA)



N
W E
S

Meters
50 0 50 100

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 11/28/2018

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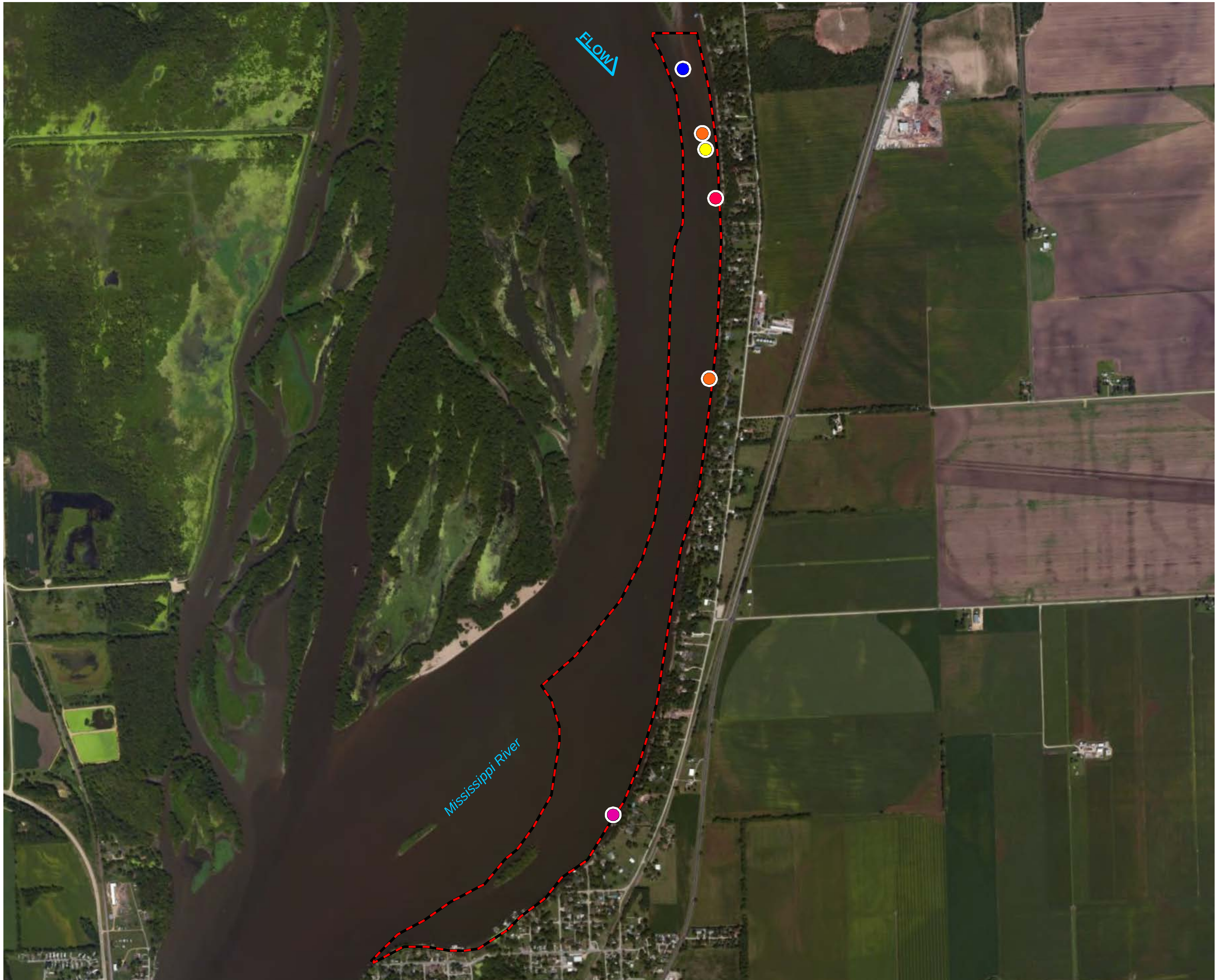
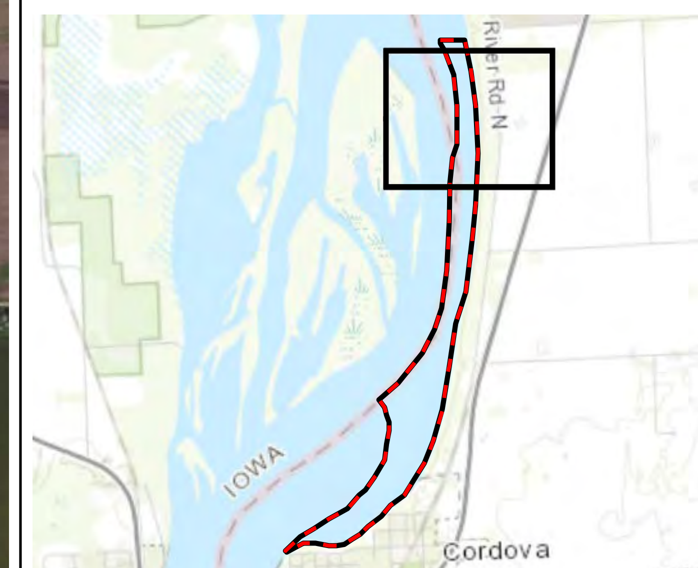
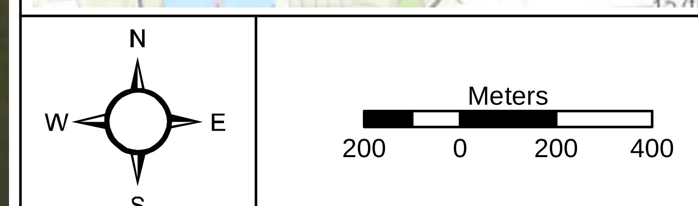


Figure 11. Qualitative mussel abundance for freshwater mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.

Catch per unit effort (CPUE) (live mussels per hour)

- 30 (1)
- 31 - 34 (2)
- 35 - 50 (1)
- 51 - 103 (1)
- 104 - 170 (1)
- Essential Habitat Area (EHA)





Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 11/28/2018

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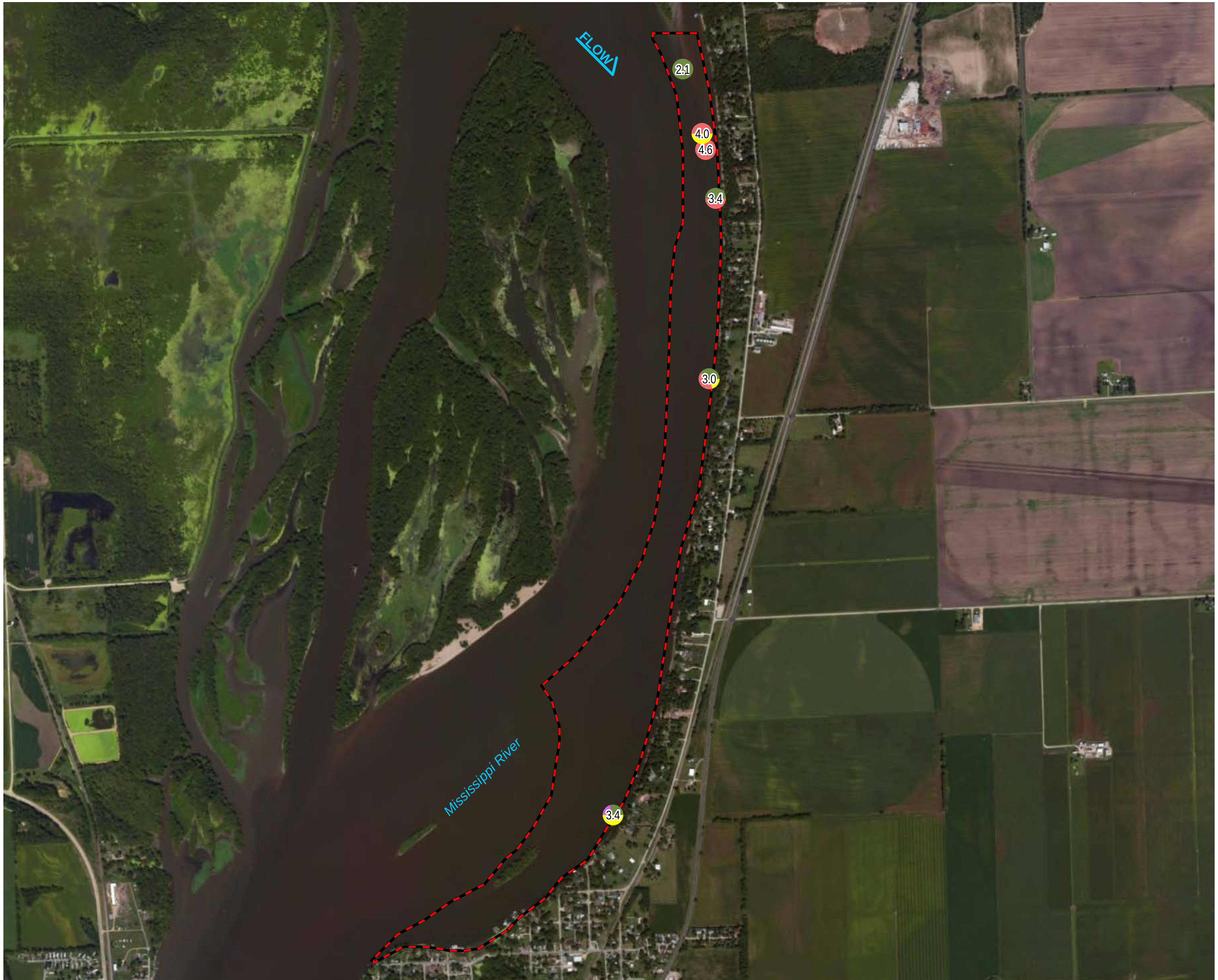

Figure 12. Qualitative sample depth and substrate composition for qualitative freshwater mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.

Quantitative Sampling Location

- Clay
- Fines
- Sand
- Gravel
- Essential Habitat Area (EHA)

Sample depths provided in meters

N W E S

Meters

200 0 200 400

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 11/28/2018

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TABLES

Table 1. Summary of quantitative and qualitative samples collected in Pools 14 and 16 at the Cordova and Buffalo Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Areas in the Upper Mississippi River, Rock Island County, Illinois and Scott County, Iowa.

			Quantitative Efforts			Qualitative Efforts		
UMRS Pool	Site	Survey Area (m^2)	Sample Area (m^2)	No. Samples	Total Area Sampled (m^2)	No. Samples	Sample Duration (min)	Total Time (min)
Pool 14	Cordova	45,000	0.25	100	25	6	30	180
Pool 16	Buffalo	85,300	0.25	150	37.5	5	30	150

Table 2. Historical unionid species list for Pool 14 in the Upper Mississippi River.

Mussel Species		
Scientific Name[1]	Common Name	Status[2]
Amblemini		
Amblema plicata	threeridge	
Anodontini		
Arcidens confragosus	rock pocketbook	
Lasmigona complanata	white heelsplitter	
Lasmigona compressa	creek heelsplitter	
Lasmigona costata	fluted shell	
Pyganodon grandis	giant floater	
Strophitus undulatus	creeper	IA_T
Utterbackia imbecillis	paper pondshell	
Utterbackiana suborbiculata	flat floater	
Lampsilini		
Actinonaias ligamentina	mucket	
Ellipsaria lineolata	butterfly	IL_T, IA_T
Epioblasma triquetra	snuffbox	FE, IL_E
Lampsilis cardium	plain pocketbook	
Lampsilis higginsii	Higgins eye pearlymussel	FE, IA_E, IL_E
Lamsilis siliquoidea	fatmucket	
Lampsilis teres	yellow sandshell	IA_E
Leptodea fragilis	fragile papershell	
Ligumia recta	black sandshell	IL_T
Obliquaria reflexa	threehorn wartyback	
Obovaria olivaria	hickorynut	
Potamilus alatus	pink heelsplitter	
Potamilus capax	fat pocketbook	FE, IL_E
Potamilus ohiensis	pink papershell	
Toxolasma parvum	liliput	
Truncilla donaciformes	fawnsfoot	
Truncilla truncata	deertoe	
Margaritiferidae		
Margaritifera monodonta	spectaclecase	FE, IA_E, IL_E
Pleurobemini		
Cyclonaias nodulata	wartyback	
Cyclonaias pustulosa	pimpleback	
Cyclonaias tuberculata	purple wartyback	IL_T, IA_T
Elliptio crassidens	elephant ear	IL_E
Eurynia dilatata	spike	IL_T
Fusconaia ebena	ebonyshell	IL_E
Fusconaia flava	Wabash pigtoe	
Plethobasus cyphyus	sheepnose	FE, IA_E, IL_E
Pleurobema sintoxia	round pigtoe	IA_E
Quadrulini		
Megalonaias nervosa	washboard	
Theliderma metanevra	monkeyface	
Quadrula quadrula	mapleleaf	
Tritogonia verrucosa	pistolgrip	IA_E

[1]Scientific nomenclature derived from Williams et al. 2017

[2]FE = federally endangered, IA_E = Iowa endangered, IA_T = Iowa threatened, IL_E = Illinois endangered, IL_T = Illinois threatened

Table 3. Historical unionid species list for Pool 16 in the Upper Mississippi River.

Mussel Species		
Scientific Name[1]	Common Name	Status[2]
Amblemini		
Amblema plicata	threeridge	
Anodontini		
Arcidens confragosus	rock pocketbook	
Lasmigona complanata	white heelsplitter	
Lasmigona costata	fluted shell	
Pyganodon grandis	giant floater	
Strophitus undulatus	creeper	IA_T
Utterbackia imbecillis	paper pondshell	
Utterbackiana suborbiculata	flat floater	
Lampsilini		
Actinonaias ligamentina	mucket	
Ellipsaria lineolata	butterfly	IL_T, IA_T
Epioblasma triquetra	snuffbox	FE, IL_E
Lampsilis cardium	plain pocketbook	
Lampsilis higginsii	Higgins eye pearlymussel	FE, IA_E, IL_E
Lampsilis teres	yellow sandshell	IA_E
Leptodea fragilis	fragile papershell	
Ligumia recta	black sandshell	IL_T
Ligumia subrostrata	pondmussel	
Obliquaria reflexa	threehorn wartyback	
Obovaria olivaria	hickorynut	
Potamilus alatus	pink heelsplitter	
Potamilus capax	fat pocketbook	FE, IL_E
Potamilus ohiensis	pink papershell	
Toxolasma parvum	liliput	
Truncilla donaciformes	fawnsfoot	
Truncilla truncata	deertoe	
Margaritiferidae		
Margaritifera monodonta	spectaclecase	FE, IA_E, IL_E
Pleurobemini		
Cyclonaias nodulata	wartyback	
Cyclonaias pustulosa	pimpleback	
Cyclonaias tuberculata	purple wartyback	IL_T, IA_T
Elliptio crassidens	elephant ear	IL_E
Eurynia dilatata	spike	IL_T
Fusconaia ebena	ebonyshell	IL_E
Fusconaia flava	Wabash pigtoe	
Plethobasus cyphyus	sheepnose	FE, IA_E, IL_E
Pleurobema sintoxia	round pigtoe	IA_E
Quadrulini		
Megalonaias nervosa	washboard	
Theliderma metanevra	monkeyface	
Quadrula quadrula	mapleleaf	
Tritogonia verrucosa	pistolgrip	IA_E

[1]Scientific nomenclature derived from Williams et al. 2017

[2]FE = federally endangered, IA_E = Iowa endangered, IA_T = Iowa threatened, IL_E = Illinois endangered, IL_T = Illinois threatenec

Table 4. Unionid species collected during 2018 quantitative and qualitative mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

Mussel Species		Quantitative				Qualitative					
Scientific Name	Common Name	No. live	Rel. Abund. (%)	No. FD[1]	No. ≤5y	No. live	Rel. Abund. (%)	No. FD[1]	No. ≤5y	Total	%
Amblemini											
Amblema plicata	threeridge	49	20.4	5	14	124	29.6	-	35	173	26.3
	Subtotal	49	20.4	5	14	124	29.6	0	35	173	26.3
Anodontini											
Arcidens confragosus	rock pocketbook	0	-	(WD)	-	1	0.2	(WD)	0	1	0.2
Lasmigona complanata	white heelsplitter	1	0.4	(WD)	0	11	2.6	-	1	12	1.8
Pyganodon grandis	giant floater	0	-	(WD)	-	3	0.7	-	1	3	0.5
Utterbackia imbecillis	paper pondshell	1	0.4	(WD)	1	2	0.5	1	2	3	0.5
	Subtotal	2	0.8	0	1	17	4.1	1	4	19	2.9
Lampsilini											
Actinonaias ligamentina	mucket	0	-	(SF)	-	0	-	-	-	0	0.0
Ellipsaria lineolata	butterfly	3	1.3	(WD)	3	2	0.5	(WD)	0	5	0.8
Lampsilis cardium	plain pocketbook	21	8.8	(WD)	6	44	10.5	-	8	65	9.9
Lampsilis higginsii	Higgins eye pearlymussel	8	3.3	(WD)	2	11	2.6	-	0	19	2.9
Lampsilis teres	yellow sandshell	1	0.4	(WD)	1	1	0.2	(WD)	0	2	0.3
Leptodea fragilis	fragile papershell	33	13.8	5	33	10	2.4	-	10	43	6.5
Ligumia recta	black sandshell	11	4.6	(WD)	1	53	12.6	-	2	64	9.7
Obliquaria reflexa	threehorn wartyback	19	7.9	2	15	48	11.5	-	38	67	10.2
Obovaria olivaria	hickorynut	1	0.4	(WD)	0	2	0.5	-	0	3	0.5
Potamilus alatus	pink heelsplitter	8	3.3	(WD)	6	13	3.1	-	5	21	3.2
Potamilus ohiensis	pink papershell	3	1.3	(WD)	3	1	0.2	-	1	4	0.6
Toxolasma parvum	liliput	11	4.6	1	11	1	0.2	(WD)	1	12	1.8
Truncilla donaciformis	fawnsfoot	28	11.7	2	28	2	0.5	(WD)	2	30	4.6
Truncilla truncata	deertoe	0	-	(WD)	-	0	-	-	0	0	0.0
	Subtotal	147	61.3	10	109	188	44.9	0	67	335	50.8
Pleurobemini											
Cyclonaias nodulata	wartyback	1	0.4	1	1	4	1.0	(WD)	4	5	0.8
Cyclonaias pustulosa	pimpleback	22	9.2	6	11	34	8.1	(WD)	3	56	8.5
Cyclonaias tuberculata	purple wartyback	0	-	(SF)	-	0	-	-	-	0	0.0
Fusconaia flava	Wabash pigtoe	9	3.8	(WD)	3	25	6.0	(WD)	6	34	5.2
Pleurobema sintoxia	round pigtoe	0	-	(WD)	-	0	-	(SF)	-	0	0.0
Plethobasus cyphyus	sheepnose	0	-	(SF)	-	0	-	-	-	0	0.0
	Subtotal	32	13.3	7	15	63	15.0	0	13	95	14.4
Quadrulini											
Megalonaias nervosa	washboard	0	-	(WD)	-	4	1.0	(WD)	0	4	0.6
Quadrula quadrula	mapleleaf	9	3.8	2	3	23	5.5		10	32	4.9
Theliderma metanevra	monkeyface	1	0.4	(WD)	0	0	-	-	-	1	0.2
Tritigonia verrucosa	pistolgrip	0	-	(WD)	-	0	-	-	-	0	0.0
	Subtotal	10	4.2	2	3	27	6.4	0	10	37	5.6
Total		240	100	24	142	419	100	1	129	659	100
Total Species		29				23				29	
Species Richness (Live)		20				22				23	
Effort (min)						180					
Avg. CPUE (no./hour)						139.7					
Density (no./m²) ± 95% CI		9.6 ± 2.30									
Population Estimate		328,585 - 535,415									

[1] FD = fresh deadshell - numbers represent the summation of fresh deadshell, WD = weathered deadshell, SF = subfossil shell

Table 5. Mussel assemblage attributes at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

Data Analysis/ Attributes		Quantitative	Qualitative	Total
Evenness (slope)		-0.214	-0.202	-
Diversity (1-D)		0.8992	0.8654	-
Rarefaction ES_x (95%CI)				
	x=10 individuals	7 (4-8.5)	NA[1]	-
	x=50 individuals	14 (10.5-16)	NA[1]	-
	x=100 individuals	17 (13.5-19)	NA[1]	-
	x=200 individuals	20 (18-22)	NA[1]	-
	x=300 individuals	NA	NA[1]	-
No. Species				
	Amblemini	1	1	1
	Anodontini	2	4	4
	Lampsilini	12	12	12
	Pleurobema	3	3	3
	Quadrulini	2	2	3
	Total	20	22	23
Abundance[2]				
	Amblemini	49 (22.1)	124 (29.6)	173 (26.3)
	Anodontini	2 (0.9)	17 (4.1)	19 (2.9)
	Lampsilini	147 (63.6)	188 (44.9)	335 (50.8)
	Pleurobema	32 (13.9)	63 (15)	95 (14.4)
	Quadrulini	10 (4.3)	27 (6.4)	37 (5.6)
	Total	240	419	659
Fresh deadshell mortality (%)		24 (9.1)	1 (0.2)[3]	27 (4.1)
No. unionids ≤ 5 years old		142	129	265
Recruitment (% ≤ 5 years old)		59.2	30.8	40.2
No. ≤ 30mm (%)		103 (42.9)	25 (6.0)	106 (16.1)
Zebra Mussel Infestation				
Zebra Mussel Density (no./m²)		0.6	-	-
No. Zebra Mussel / unionid[2]				
	0	225 (93.75)	409 (97.6)	634 (96.1)
	1 - 5	15 (6.25)	10 (2.4)	25 (6.0)
	6-10	0 (0.0)	0 (0)	0 (0)
	> 10	0 (0.0)	0 (0)	0 (0)
% Zebra Mussel Coverage[2]				
	0	225 (93.75)	409 (97.6)	634 (96.1)
	1 - 10	11 (4.6)	4 (0.95)	15 (2.3)
	11 - 50	4 (1.7)	6 (1.4)	10 (1.5)
	51 - 100	0 (0.0)	0 (0.0)	0 (0.0)

[1]Accurate confidence intervals could not be established due to a lack of sampling units

[2]Relative abundance provided in parentheses (%)

Table 6. Quantitative mussel density and population estimates at Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

Species	No. live	Relative Abundance (%)	Density (no./m²)	95% CI[1]	Population Estimate	95% CI[1]
Amblemini						
Amblema plicata	49	20.4	1.96	1.05 - 2.87	88,200	47,462-128,968
Anodontini						
Lasmigona complanata	1	0.4	0.04	0-0.12	1,800	0-5,372
Utterbackia imbecillis	1	0.4	0.04	0-0.12	1,800	0-5,372
Lampsilini						
Ellipsaria lineolata	3	1.3	0.12	0-0.26	5,400	0-11,523
Lampsilis cardium	21	8.8	0.84	0.46-1.22	37,800	20,739-54861
Lampsilis higginsii	8	3.3	0.32	0.03-0.61	14,400	12,80-27,520
Lampsilis teres	1	0.4	0.04	0-0.12	1,800	0-5,372
Leptodea fragilis	33	13.8	1.32	0.78-1.86	59,400	35,025-83,775
Ligumia recta	11	4.6	0.44	0.19-0.69	19,800	8,569-31,031
Obliquaria reflexa	19	7.9	0.76	0.37-1.15	34,200	16,840-51,560
Obovaria olivaria	1	0.4	0.04	0-0.12	1,800	0-5,372
Potamilus alatus	8	3.3	0.32	0.10-0.54	14,400	4,662-24,138
Potamilus ohiensis	3	1.3	0.12	0-0.30	5,400	0-13,354
Toxolasma parvum	11	4.6	0.44	0.00-0.88	19,800	208-39,392
Truncilla donaciformis	28	11.7	1.12	0.67-1.57	50,400	30,044-70,756
Pleurobemini						
Cyclonaias nodulata	1	0.4	0.04	0-0.12	1,800	0-5,372
Cyclonaias pustulosa	22	9.2	0.88	0.45-1.31	39,600	20,216-58,984
Fusconaia flava	9	3.8	0.36	0.11-0.61	16,200	4,741-27,659
Quadrulini						
Quadrula quadrula	9	3.8	0.36	0.11-0.61	16,200	4,741-27,659
Theliderma metanevra	1	0.4	0.04	0-0.13	1,800	0-5,372
Total	240		9.60	7.30 - 11.90	432,000	328,585-535,415

[1]CI = Confidence Interval; Negative CI truncated to 0

Table 7. Age frequency distribution of live mussels collected during quantitative survey efforts at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

	Age (external annuli estimation)																				
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	19	≥20	Total
Amblemini																					
Amblema plicata		3	3	3	4	1	7	10	8	9	1										49
Anodontini																					
Lasmigona complanata																	1				1
Utterbackia imbecillis		1																			1
Lampsilini																					
Ellipsaria lineolata		1	1	1																	3
Lampsilis cardium	2		1	2	1			1	3	1	2	1	3	2	1		1				21
Lampsilis higginsii				2					1	1	1		2	1							8
Lampsilis teres					1																1
Leptodea fragilis	7	15	5	5	1																33
Ligumia recta					1				1	3	2	1	1	1	1						11
Obliquaria reflexa		4	1	5	2	3	2	2													19
Obovaria olivaria							1														1
Potamilus alatus		4	1		1			1	1												8
Potamilus ohiensis		1		1	1																3
Toxolasma parvum			5	5	1																11
Truncilla donaciformis		1	13	11	3																28
Pleurobemini																					
Cyclonaias nodulata		1																			1
Cyclonaias pustulosa	1	5	1		3	1	1	4	1	1	3					1					22
Fusconaia flava			2	1			1		3	2											9
Quadrulini																					
Quadrula quadrula		1				2		2	2	1	1										9
Theliderma metanevra															1						1
Grand Total	10	37	33	36	19	7	12	20	20	18	10	2	6	4	3	1	2	0	0	0	240
Total %	4.2	15.4	13.8	15.0	7.9	2.9	5.0	8.3	8.3	7.5	4.2	0.8	2.5	1.7	1.3	0.4	0.8	0.0	0.0	0.0	100.0

Table 8. Length frequency distribution of live mussels collected during quantitative survey efforts at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

	length (mm, anterior to posterior)																														
Species	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	100-105	105-110	110-115	115-120	120-125	125-130	130-135	135-140	140-145	145-150	Abundance
Amblemini																															
Amblema plicata		1	4	2	1	4	2		1	1		4	7	6	8	4	2			2											49
Anodontini																															
Lasmigona complanata																														1	1
Utterbackia imbecillis					1																										1
Lampsilini																															
Ellipsaria lineolata				1	2																										3
Lampsilis cardium		1					1		1	1	1	1							2	3	5	3	1		1						21
Lampsilis higginsii					2										1	1			1	3											8
Lampsilis teres																	1														1
Leptodea fragilis		2	1	6	1	5	3		3	3		5	1	1			1		1												33
Ligumia recta													1									1	3		2		2	2			11
Obliquaria reflexa		3	1	1		6	1	1	5	1																					19
Obovaria olivaria										1																					1
Potamilus alatus				2	1	1		1												1	1	1									8
Potamilus ohiensis					1				1							1															3
Toxolasma parvum		2	9																												11
Truncilla donaciformis		7	17	4																											28
Pleurobemini																															
Cyclonaias nodulata		1																													1
Cyclonaias pustulosa		4	3			3	1	1	3	2		4			1																22
Fusconaia flava			2				1		1	2			2	1																	9
Quadrulini																															
Quadrula quadrula		1						1	1			2	3	1																	9
Theliderma metanevra																									1						1
Grand Total	0	22	37	16	9	19	9	4	16	11	1	16	14	9	10	6	4	0	4	9	6	5	4	0	4	0	2	2	0	1	240
Total %	0.0	9.2	15.4	6.7	3.8	7.9	3.8	1.7	6.7	4.6	0.4	6.7	5.8	3.8	4.2	2.5	1.7	0.0	1.7	3.8	2.5	2.1	1.7	0.0	1.7	0.0	0.8	0.8	0.0	0.4	100.0

Table 9. Habitat attributes during mussel survey efforts in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

		Depth (m)			Average % Substrate Composition						
Effort Type	No. Samples	Ave.	Min.	Max.	Bedrock	Boulder	Cobble	Gravel	Sand	Silt	Clay
Quantitative	100	3.5	0.9	6.1	0.0	0.0	0.0	16.1	57.3	12.8	13.9
Qualitative	6	3.4	2.1	4.6	0.0	0.0	0.0	20.0	40.0	3.3	36.7

Table 10. Power analysis of live mussels collected during quantitative survey efforts in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

		Pool 14 at Cordova
Sample Size (# quadrats)		100
Mean Mussel Density (individuals / m^2)		9.60
95% Confidence Interval		2.30
Standard Deviation		11.58
Precision[1]		24.0%
		No. of Samples
Precision Level[1]		
	15%	259
	20%	146
	25%	93

[1]Precision level = 95% CI of mean

Table 11. Federally endangered mussels collected in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

Sample ID	Species	New Tag(s)[1]	Sex	Age (years)	Length (mm)	Substrate Composition	Depth (m)	No. Zebra Mussels	FORMER Sample ID
Stockpile_S	*Lampsilis higginsii*	C246	F	8	85.4	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C265	F	9	90.7	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C511	F	7	93.2	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C483	M	10	96.8	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C402	M	10	97.0	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C341	M	11	104.1	50% gravel 30% clay 20% fines	3.4	0	Qual_06
201809281539	*Lampsilis higginsii*	0528-0529	M	12	91.9	40% clay 40% sand 20% gravel	3.0	0	Qual_04
201809281539	*Lampsilis higginsii*	0526-0527	F	8	69.1	100% clay	2.1	0	Qual_04
201809281538	*Lampsilis higginsii*	0524-0525	F	7	72.5	50% gravel 50% sand	4.0	0	Qual_03
201809281538	*Lampsilis higginsii*	0522-0523	M	8	90.8	50% gravel 50% sand	4.0	0	Qual_03
201809281536	*Lampsilis higginsii*	0520-0521	F	9	70.9	50% clay 50% sand	3.4	0	Qual_01
201809281524	*Lampsilis higginsii*	no tag	J	3	28.2	50% gravel 50% sand	4.3	0	89
201809281506	*Lampsilis higginsii*	0514-0515	M	8	71.8	50% clay 50% gravel	3.0	0	71
201809281506	*Lampsilis higginsii*	0516-0517	F	10	75.1	50% clay 50% gravel	3.0	0	71
201809281506	*Lampsilis higginsii*	0518-0519	M	13	100.0	50% clay 50% gravel	3.0	0	71
201809271561	*Lampsilis higginsii*	0512-0513	M	9	91.9	50% clay 50% sand	4.9	0	61
201809271556	*Lampsilis higginsii*	0510-0511	M	12	99.0	50% clay 50% sand	4.0	0	56
201809271554	*Lampsilis higginsii*	no tag	J	3	29.4	100% clay	2.1	0	54
201809271540	*Lampsilis higginsii*	0508-0509	M	12	99.1	100% sand	4.9	0	40

[1]Orange tags

Table 12. Length frequency distribution of live mussels collected during qualitative survey efforts at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

	length (mm, anterior to posterior)																														
Species	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	100-105	105-110	110-115	115-120	120-125	125-130	130-135	135-140	140-145	145-150	150-155	
Amblemini																																
Amblema plicata				3	2	5	7	3	5	5	5	10	8	14	16	16	11	9	5													124
Anodontini																																
Arcidens confragosus																			1													1
Lasmigona complanata																			1				1		1	1	3	2	1	1		11
Pyganodon grandis								1											1										1			3
Utterbackia imbecillis									2																							2
Lampsilini																																
Ellipsaria lineolata											1				1																	2
Lampsilis cardium										1	1			1	1	2	1	1	4	8	3	8	7	5	1							44
Lampsilis higginsii														1	2			1	4	2	1											11
Lampsilis teres																	1															1
Leptodea fragilis										1	4	3						2														10
Ligumia recta																		1		1		3		10	11	8	10	6	1	1	1	53
Obliquaria reflexa				1	2	1	10	8	12	13	1																					48
Obovaria olivaria											2																					2
Potamilus alatus									1				2	1		2	1			1	3					1		1				13
Potamilus ohiensis									1																							1
Toxolasma parvum				1																												1
Truncilla donaciformis			1	1																												2
Pleurobemini																																
Cyclonaias nodulata						1	1	1	1																							4
Cyclonaias pustulosa						2	2	3	5	3	8	7	4																			34
Fusconaia flava					3	2	1	2	5	1	3	6	2																			25
Quadrulini																																
Megalonaias nervosa																			1						1				2			4
Quadrula quadrula							3	2	5	2		3	2	4		1	1															23
Grand Total	0	0	1	6	7	11	24	20	37	26	25	29	18	21	20	21	15	14	17	12	7	11	8	15	14	10	13	9	5	2	1	419
Total %	0	0	0.2	1.4	1.7	2.6	5.7	4.8	8.8	6.2	6	6.9	4.3	5	4.8	5	3.6	3.3	4.1	2.9	1.7	2.6	1.9	3.6	3.3	2.4	3.1	2.1	1.2	0.5	0.2	100

Table 13. Age frequency distribution of live mussels collected during qualitative survey efforts at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

	Age (external annuli estimation)																					
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	≥20	Total
Amblemini																						
Amblema plicata			4	10	7	14	12	27	18	19	5	4	3	1								124
Anodontini																						
Arcidens confragosus										1												1
Lasmigona complanata						1		1	1	2	3		2	1								11
Pyganodon grandis			1				1				1											3
Utterbackia imbecillis			1	1																		2
Lampsilini																						
Ellipsaria lineolata							1	1														2
Lampsilis cardium				5	2	1	3	7	13	5	5	1	1	1								44
Lampsilis higginsii								2	3	2	2	1	1									11
Lampsilis teres							1															1
Leptodea fragilis		1	7		2																	10
Ligumia recta						2		1	1	5	4	14	11	10	1	3	1					53
Obliquaria reflexa			3	6	12	17	6	3				1										48
Obovaria olivaria							1		1													2
Potamilus alatus			2	1	1	1	3	2	1	1		1										13
Potamilus ohiensis				1																		1
Toxolasma parvum			1																			1
Truncilla truncata			1	1																		2
Pleurobemini																						
Cyclonaias nodulata				1	2	1																4
Cyclonaias pustulosa					3		8	5	4	5	5	4										34
Fusconaia flava				5		1	5	1	3	5	1	4										25
Quadrulini																						
Megalonaias nervosa							1								1	1					1	4
Quadrula quadrula				1	8	1	2	2	5	2		2										23
Grand Total	0	1	20	32	37	39	44	52	50	47	26	32	18	13	2	4	1	0	0	0	1	419
Total %	0.0	0.2	4.8	7.6	8.8	9.3	10.5	12.4	11.9	11.2	6.2	7.6	4.3	3.1	0.5	1.0	0.2	0.0	0.0	0.0	0.2	100.0

US Army Corps of Engineers
Rock Island District

Steamboat Island HREP - Tentatively Selected Plan

As of: 1/22/2019

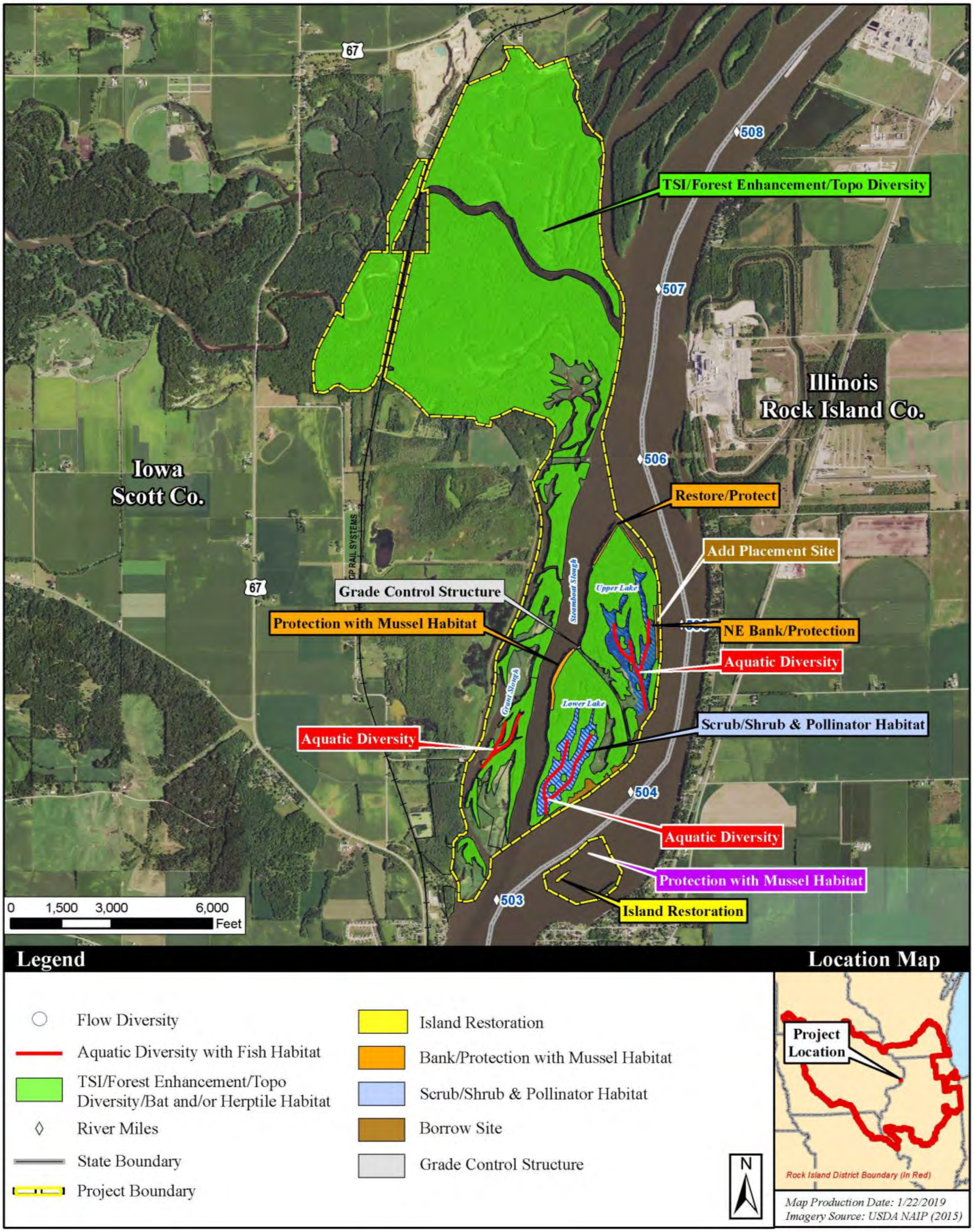
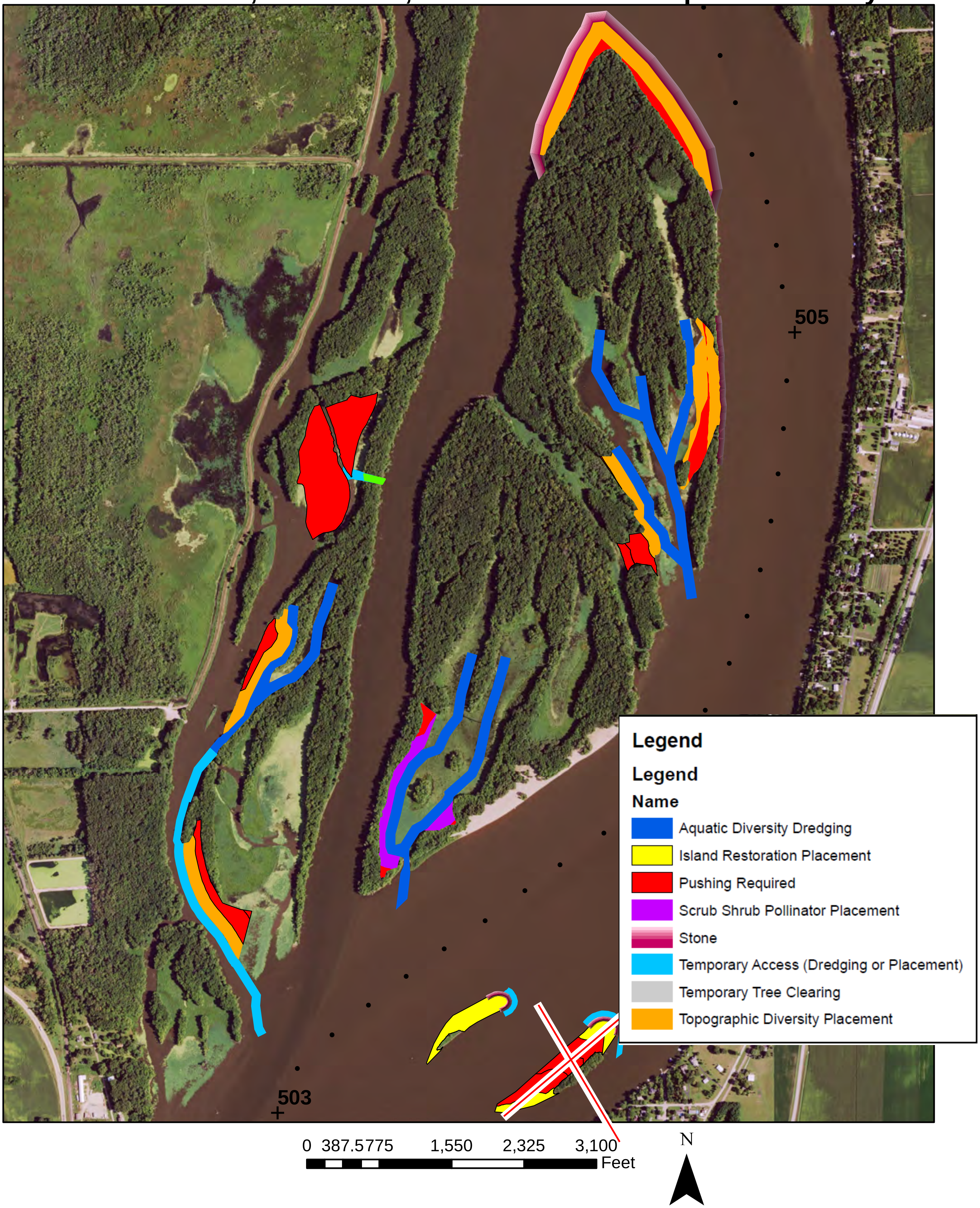
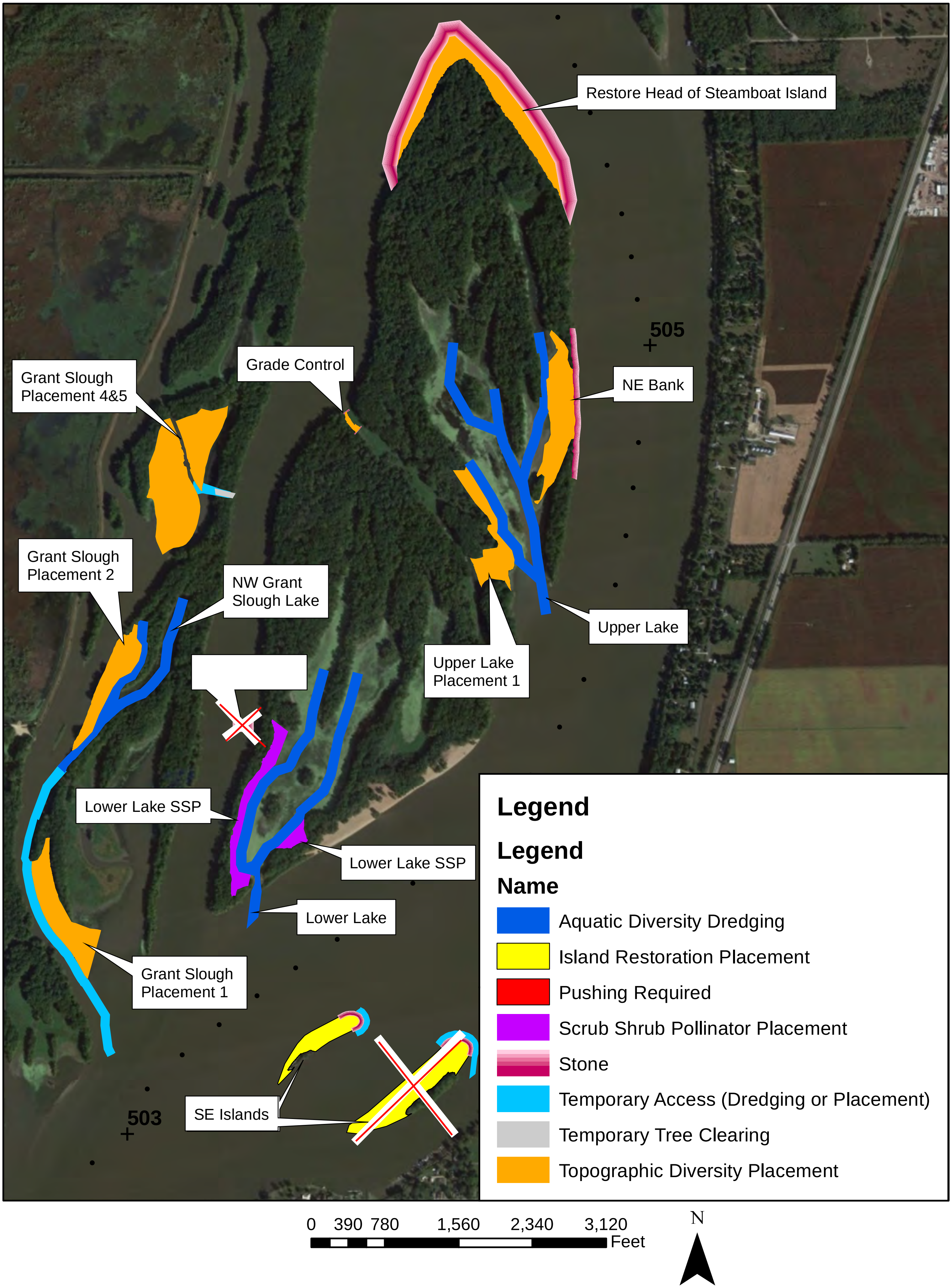


Figure 3

[27] Grant Slough Complex, Upper Steamboat Island (Head) Restoration and Protection, SE Islands, Steamboat Island Aquatic Diversity



Steamboat Island



Map notes:
Red features = eliminated

UMRR
Feasibility Report with Integrated EA

Steamboat Island HREP
Scott County, Iowa

Any access dredging impacts need to be included in FR/EA Ch 9.

A. Aquatic Diversity, Topographic Diversity, and Scrub-Shrub/Pollinator Habitat

1. Aquatic Diversity Measures (see Figure 1 for locations of these measures).

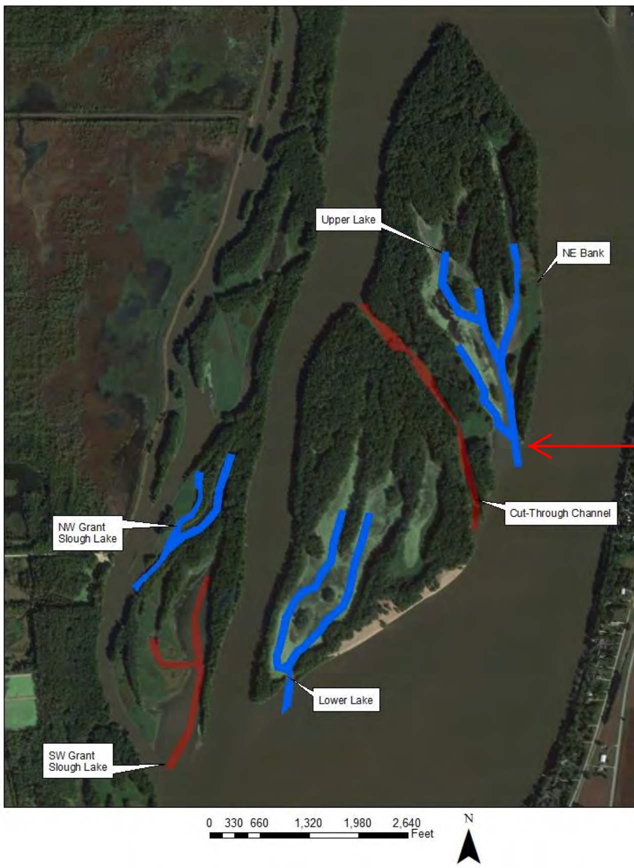


Figure 1: Aquatic Diversity Locations

Kyle explained that what is shown is what was used for widths to determine quantities (we only see top widths here). He included a 60-foot (at least) bottom width, but there are some more narrow spots.

a. **Steamboat Island Upper Lake Aquatic Diversity.** Upper Lake would be excavated to provide aquatic diversity through the direct act of dredging and to provide material for floodplain forest topographic diversity. The cut was aligned to follow naturally deeper areas and tie into the deeper water of the Mississippi River channel. Following naturally deeper areas minimizes dredging costs and may allow for increased lifespan of the cut. Upper Lake would be constructed only in combination with addressing the breached natural berm referred to as the Northeast Bank (NE Bank). The NE Bank has eroded and water from the Mississippi River channel currently flows into Upper Lake, depositing sediment into the lake.

Group concurred to keep aquatic diversity measures, as is.

Scott Gritters requested the incorporation of fish habitat enhancement measures (deep holes, wider "lakes" in cuts, anchored logs, etc). Kyle shared that those would be ironed out in Plans & Specs, but we would include examples or general concepts now. USFWS and DNR will coordinate and provide one set of proposals to the Corps regarding ideas for fish habitat enhancement.

b. Steamboat Island Lower Lake Aquatic Diversity. Lower Lake would be excavated to provide aquatic diversity through the direct act of dredging and to provide material for floodplain forest topographic diversity and scrub-shrub/pollinator habitat. The cut was aligned to follow naturally deeper areas and tie into the deeper water of the Mississippi River channel. Following naturally deeper areas minimizes dredging costs and may allow for increased lifespan of the cut.

c. Northwest Grant Slough Lake Aquatic Diversity. Northwest Grant Slough Lake would be excavated to provide aquatic diversity through the direct act of dredging and to provide material for floodplain forest topographic diversity and scrub-shrub/pollinator habitat. The cut was aligned to follow naturally deeper areas and tie into Grant Slough. Following naturally deeper areas minimizes dredging costs and may allow for increased lifespan of the cut.

2. Topographic Diversity Measures.

Topographic diversity sites will be divided into ½ acre plots, which will be planted with one size of tree [#3, #5, or #15 root pruned method (RPM) trees]. This planting approach allows for more efficient monitoring and evaluation should future questions arise about the effectiveness, efficiency and performance of the planted trees. Three sizes of trees offers a more realistic representation of the optimal structure of the bottomland hardwood forest, which then provides a more resilient and sustainable functioning floodplain ecosystem. Trees will be planted over a three year span in an effort to ensure survivability should any one year have adverse conditions. Forested wetland shrubs will be interplanted with the forested wetland trees. The understory seed mixture will be planted below the shrubs and trees. A buffer mix that includes seeds and willow stakes will be planted on the slopes approaching the planting areas to reduce herbivory of the tree plantings. Figure 2 shows the locations of these measures.

Geotech borings will help determine how successful plantings will be and what other material is needed for topographic diversity.

Map notes:
Red features = eliminated

Commented [NKRCUC(1]: Update when GS1 is decided as forestry or SSP (color red or keep orange)

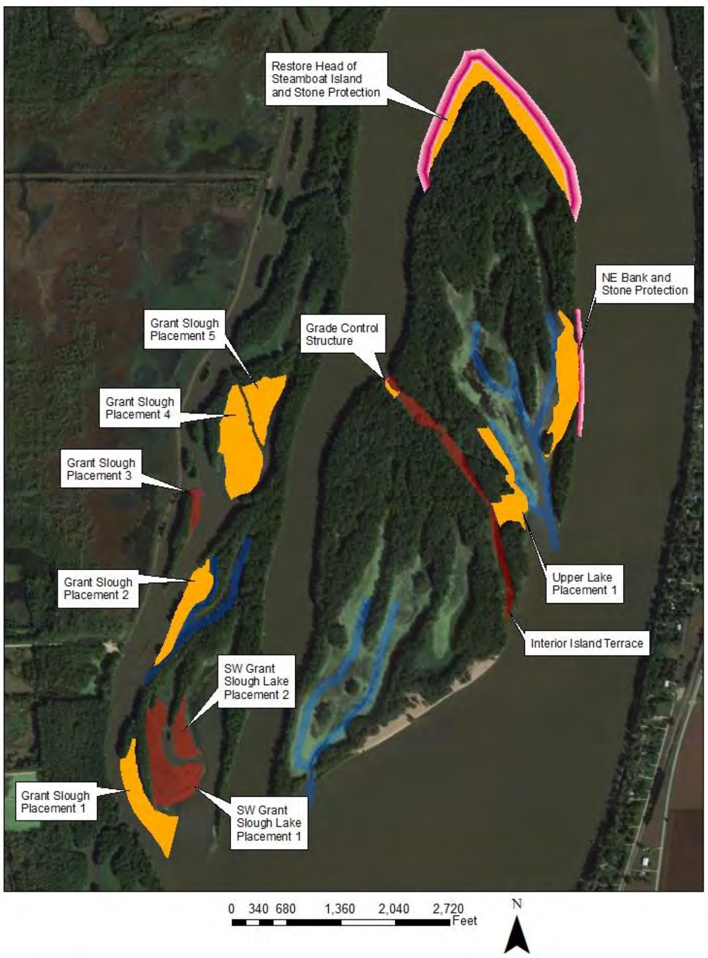


Figure 2: Topographic Diversity Locations.

a. Restore Head of Steamboat Island. Restoring the head of Steamboat Island as a topographic diversity site serves several purposes. It meets the objective of creating topographic diversity in an area that has lost forest habitat over the years due to erosion, but will also help protect Steamboat Island from further erosion. This site is open water placement and requires stone protection to keep the material from eroding into the Mississippi River. Restoring this area to optimum tree survival elevations also provides an increased buffer to Upper Lake, which will help slow down water during high flows, drop out sediment, and help combat sedimentation in Upper Lake.

Group concurred to keep topographic diversity measure, as is.

Group concurred to keep topographic diversity measure, as is.

b. NE Bank. Restoring the NE Bank of Steamboat Island as a topographic diversity site serves several purposes. It meets the objective of creating topographic diversity in an area that has lost forest habitat over the years due to erosion, and it will help protect Upper Lake from sediment-laden flows that are currently flowing in from the Mississippi River channel. Restoring this area to optimum tree survival elevations provides an increased buffer to Upper Lake, which will help slow down water during high flows, drop out sediment, and help combat sedimentation in Upper Lake. During lower flows, water from the Mississippi River will no longer enter Upper Lake through the breached area. This site includes on-land placement in reeds canary flats and open water placement. This requires stone protection to keep the material from eroding into the river.

Group concurred to keep topographic diversity measure, as is.

c. Upper Lake Placement 1. Upper Lake Placement 1 was chosen because it is a reeds canary flat and is in close proximity to Upper Lake. It meets the objective of creating topographic diversity and provides a large increase in habitat value, as it is currently a monoculture of plant species. The original discussion for this location had a smaller footprint and bridged the gap between Upper Lake and the cut-through channel. PDT discussions led to increasing the footprint of this placement site to extend northwesterly along Upper Lake. This increased footprint provides for an increased buffer to Upper Lake, which will help slow down water during high flows, drop out sediment, and help combat sedimentation in Upper Lake.

Group concurred to keep topographic diversity measure, as is.

d. Grade Control Structure. The primary role of the grade control structure is to slow down the flow entering the cut-through channel and provide protection to Lower Lake from sediment laden water by acting as a filter, but would also provide topographic diversity and scrub-shrub and pollinator habitat. The measure would be constructed to an elevation near the lower limit for moderately tolerant trees. The structure includes stone protection to combat erosive forces during high flows.

This site may need protection due to high winds causing erosive forces.
USFWS & DNR do not have a preference between Forestry and SSP for GS1, but would like Ben's assessment for habitat needs to make that decision.
How will invasive species management impact the success of the site and selection of habitat type? Can we "test" each habitat to see which one results in lower invasive species management?

e. Grant Slough Placement 1. This site was chosen because it is a reeds canary flat and is in close proximity to the proposed dredging in Southwest Grant Slough Lake. Dredging in Southwest Grant Slough Lake was not retained for further evaluation, but the placement site was retained because it meets the objective of creating topographic diversity and provides a large increase in habitat value, as it is currently a monoculture of plant species.

f. Grant Slough Placement 2. This site was chosen because it is a reeds canary flat and is in close proximity to the proposed dredging in Northwest Grant Slough Lake. It would meet the objective of creating topographic diversity and provide a large increase in habitat value, as it is currently a monoculture of plant species. Restoring this area to optimum tree survival elevations provides an increased buffer to Northwest Grant Slough Lake, which will help slow down water during high flows, drop out sediment, and help combat sedimentation in Northwest Grant Slough Lake.

Group concurred to keep topographic diversity measure, as is.

g. Grant Slough Placement 4 and 5. These sites were chosen because they are reeds canary flats. They are two physically different sites, separated by a small channel, but are combined for discussion as they would likely be constructed together. The placement sites meet the objective of creating topographic diversity and provide a large increase in habitat value, as it is currently a monoculture of plant species. Restoring these areas to optimum tree survival elevations provides a large tract of topographic diversity. A minor amount of tree clearing between the placement sites and Steamboat Slough will be required for access. Access dredging into the sites from Grant Slough was evaluated, but deemed more costly than tree clearing.

Group concurred to keep topographic diversity measure, as is.

Map notes:
Red features = eliminated

3. *Scrub Shrub Pollinator Habitat Measures.* Planting native scrub-shrub/pollinator species on the raised placement areas has been proposed as a potential measure to increase scrub-shrub wetlands and pollinator habitat areas in the Project area. The scrub-shrub/pollinator sites were determined based on proximity to proposed aquatic diversity dredge cuts and existing habitat. Sites near aquatic diversity dredge cuts allow for side cast placement and less handling of material. Sites near existing scrub-shrub and pollinator habitats will help protect the existing habitat and will increase and enhance the habitat in that area. Figure 3 shows the locations of these measures.

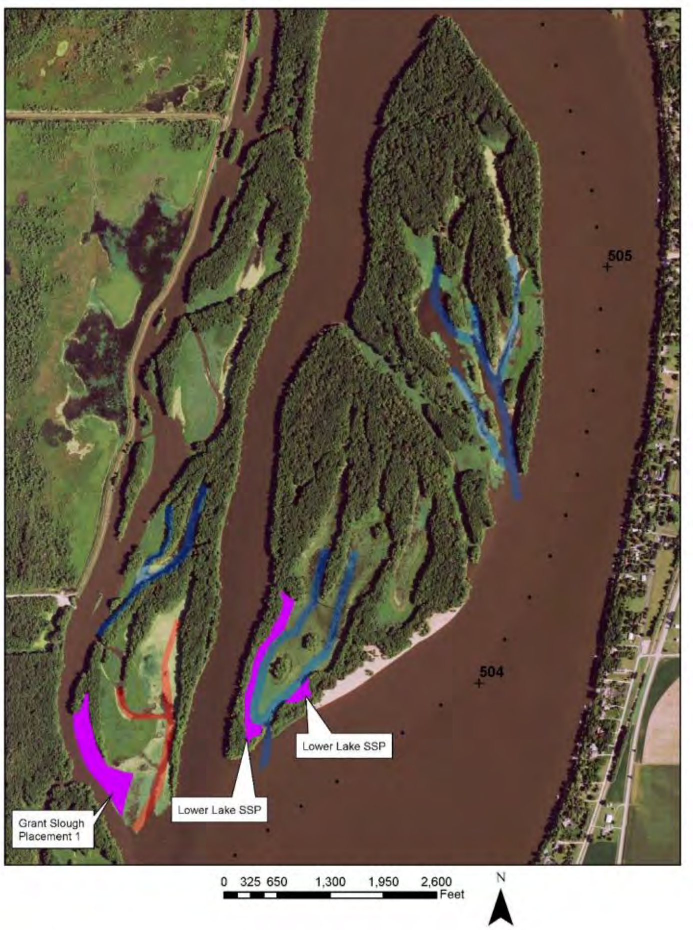


Figure 3: Scrub Shrub Pollinator Locations.

Commented [NKRCUC(2]: Update if GS1 is forestry (color red or keep purple)

Group concurred to keep Scrub-Shrub/ Pollinator measure, as is.

a. Lower Lake. Two sites were identified in Lower Lake for scrub-shrub/pollinator habitat but are considered one location for discussion. Both sites are currently open water. The east site is

Map notes:
Red features = eliminated

This site may need protection due to high winds causing erosive forces.

USFWS & DNR do not have a preference between Forestry and SSP for GS1, but would like Ben's assessment for habitat needs to make that decision.

How will invasive species management impact the success of the site and selection of habitat type? Can we "test" each habitat to see which one results in lower invasive species management?

adjacent to existing stands of button bush and other wetland species. The west site is adjacent to bottomland forest, but will create a transition zone between aquatic and terrestrial habitats. These sites would be raised to optimum scrub-shrub/pollinator survival elevations and planted to scrub shrub pollinator species. Adjacent areas with existing scrub shrub pollinator species will be enhanced with timber stand improvement (TSI) methods such as coppicing of button bush.

b. Grant Slough Placement 1. This site was chosen because it is a reeds canary flat and is in close proximity to the proposed dredging in Southwest Grant Slough Lake. Dredging in Southwest Grant Slough Lake was not retained for further evaluation, but the placement site has been kept because it meets the objective of creating scrub-shrub/pollinator habitat and provides a large increase in habitat value, as it is currently a monoculture of plant species.

B. <u>Small Island Restoration and Protection – West SE Island ("Channel-side Island")</u>

Some small islands still exist in the Project area, but have been eroding significantly since construction of the locks and dams and associated inundation. Islands create a variety of habitats including terrestrial zones, aquatic zones, and the transitional zones. Terrestrial zones can include topographic diversity and forestry benefits. Aquatic zones can include subsurface structure for fish, mussels, and other aquatic species. Transitional zones bridge the gap between these habitats. Islands alter hydraulic connectivity, create flow diversity, and lower wind fetch. Islands may be restored through material placement to desired elevations and footprints. Depending on river velocities, erosion protection may be required. Figure 4 shows the locations of these measures.

The west SE Island is a naturally occurring island in the pool and has also been used as a dredged material placement site, but has eroded significantly due to inundation. The footprint for restoring the West SE Island is based on aerial imagery from the 1990s which show fairly consistent island geometry. Restoring the island to optimum tree survival elevations allows for the island to be planted with trees and other vegetation, which will help hold material in place against erosion. This creates a topographically diverse site. Stone protection will also be required to combat erosive forces of the Mississippi River.

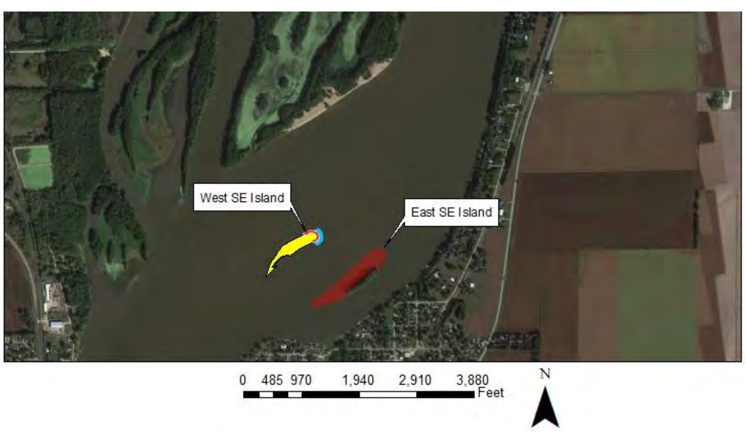


Figure 4: Small Island Restoration and Protection Locations.

Plans & Specs/Design need to consider the wave wash and southern winds causing erosive forces to these islands and how that will affect construction and long-term success. Scott suggested adding in rock structures (weirs/vanes) on the northwest side of the island to prevent erosion from navigational and recreational boating (similar to what was done at a Pool 10 project and Busey Lake. Erica suggested a near-shore berm to break up wave action.
Modeling efforts will change rock quantities and footprint.

Group concurred on the island restoration feature, knowing it may change depending on real estate holdings and how that affects design.

C. Forest Habitat (Timber Stand Improvement).

1. Forest Habitat Measures.
a. Location?
(Note: include secondary benefits to bats)

D. Mussel Habitat Incorporation. Enhancing and maintaining existing mussel habitat by incorporating with other measures has been considered by the PDT. This measure includes placing mussel substrate, such as river stone, when constructing other measures like stone protection or dredged material placement sites.

Locations and size of mussel substrate can be decided during Plans & Specs, but we would include examples or general concepts now. USFWS and DNR will coordinate and provide one set of proposals to the Corps regarding ideas for mussel habitat incorporation.

1. Restoring Head of Island. Restoring the Head of Steamboat Island was proposed as a topographic diversity measure. This restoration will likely require stone protection due to high velocities from the Mississippi River. If appropriate conditions are present, mussel habitat can be incorporated into the stone protection.

2. NE Bank. The NE Bank was proposed as a topographic diversity measure. This restoration will likely require stone protection due to high velocities from the Mississippi River. If appropriate conditions are present, mussel habitat can be incorporated into the stone protection.

3. SE Islands. The SE Islands were proposed as island restoration and topographic diversity measures. This restoration will likely require stone protection due to high velocities from the Mississippi River. If appropriate conditions are present, mussel habitat can be incorporated into the stone protection.

Grant Slough Placement 1 should be added if protection is added to the topographic diversity site.

From: Schmuecker, Sara
To: Michl, Davi E CIV [redacted]
Cc: Gritters, Scott; Perrine, Rachel E [redacted] Stephens, Erica L [redacted] Nerad, Kyle R [redacted]
Subject: [Non-DoD Source] Re: [EXTERNAL] Steamboat 2019 Mussel Survey - Bathymetry Maps + Meeting Notes (UNCLASSIFIED)
Date: Tuesday, April 9, 2019 11:05:09 AM

Looks good! I provided just a couple quick comments, below.

Thanks,

Sara

Sara Schmuecker
U.S. Fish and Wildlife Service
Illinois - Iowa Field Office
1511 47th Avenue, Moline, IL 61265
[redacted]

On Tue, Apr 9, 2019 at 8:29 AM Michl, Davi E CIV USARMY CEMVP (US) [redacted] wrote:

> CLASSIFICATION: UNCLASSIFIED
>
> *html
>
> Sara/Scotty,
>
> Per our 2 APR 2019 meeting, I have attached bathymetry maps of Grant Slough and the West SE Island to help make a determination of where you would like to see additional spot dives/quadrats for the upcoming 2019 Mussel Survey and whether the FWS Dive Team will be able to survey based on depths.
>
> Kyle, Scotty wondered what the width of the access dredge cut in Grant Slough would be -- do you have this info? Also, will there be some sort of access channel for the West SE Island beyond the horseshoe at the head of the island?
>
> General meeting minutes (feel free to revise, as needed):

- Grant Slough

    o FWS/DNR would like to see additional survey points (quads? Spot dives?) in between the 2018 survey points to fill in the gaps cover our bases for ~~the BA~~ Section 7 consultation. Survey points would be focused towards the downstream end of Grant Slough where access dredging is planned.

- West SE Island

    o Need to define area of impact, including any access dredging that will occur here (Kyle?)

    o 8' limit to FWS diving

    o FWS/DNR would like to see a mixture of quadrats/spot dives in high mussel density areas here After the impact area and access channel (if needed) have been defined, we'd like to fill in any spatial gaps to certify the whole area of impact has been surveyed due to its proximity to the Cordova EHA.

- Other notes

    o At this time, a bat survey is not required, but we may adjust as we approach design phase Correct. Early in the planning process we discussed that there would be no clear cutting and any limited/select cutting would be conducted outside of the Indiana bat maternity season.

    o No Eastern massasauga rattlesnake survey are required

Please let me know if I captured our discussion accurately—thanks!

V/R,

Davi Michl

Regional Planning and Environment Division North

U.S. Army Corps of Engineers

[redacted]

CEMVR-PM-M 06 JUN 2019

MEMORANDUM FOR RECORD CEMVD-PDM [Mary (LeeAnn) Riggs]

SUBJECT: In-Progress Review (IPR) Teleconference for the Upper Mississippi River Restoration (UMRR) Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP)

1. References:

   a. EC 1165-2-217 Civil Works Review Policy, 20 February 2018

   b. ER 1105-2-100 Planning Guidance Notebook, 22 April 2000

   c. EP 1105-2-58 Continuing Authorities Program, 01 March 2019

   d. "*Steamboat Island HREP IPR April 2019 MFR Attachments.pdf*", UMRR Steamboat Island HREP IPR slide deck, 11 April 2019

2. April 11, 2019 IPR Attendees:

MVD:
Kendall Smith
Daniel (Brian) Chewning
Gary Young
Matthew Mallard
Mary (LeeAnn) Riggs
Jennifer Ryan
Brynn Morgan
Randel Holder
George (Thatch) Shepard
James Briggs
Gregory Miller

RPEDN (MVP):
Karla Sparks, MVR Plan Formulation Chief
Rachel Perrine, Lead Planner
Jodi Creswell, RPEDN Environmental Planning Branch Chief
Camie Knollenberg, RPEDN Plan Formulation Chief
Terry Birkenstock, Acting Chief, RPEDN

MVR:
Erica Stephens, Project Manager
Kyle Nerad, Civil Engineer/Design Lead

3. Agenda:

a. Study Overview

b. Steamboat Island HREP Overview

c. Alternative Development/Evaluation

d. Tentatively Selected Plan (TSP)

e. Risk-Informed Decision Making

f. Schedule

g. IPR Comments/Concurrence

4. Purpose: To discuss the TSP for the Steamboat Island UMRR HREP (Project) and confirm MVD support for the path forward.

5. Discussion: *See reference d. "Steamboat Island HREP IPR April 2019 MFR Attachments.pdf" for IPR slides deck (information added to original slide deck in blue italics).*

Slide 4: The original approved Fact Sheet included Steamboat Island proper only, but the Revised Fact Sheet includes Grant Slough, the Wapsipinicon bottoms, and islands located southeast of Steamboat Island proper. MVD approved the Revised Fact Sheet on May 22, 2018. This expansion will allow the Project to restore, enhance, and increase additional bottomland forest, floodplain habitat, and aquatic habitats.

Slide 5: Human activity, years of silt deposition, and high water elevation through impoundment of the Upper Mississippi River (UMR) have altered the hydrology (i.e. increased water inundation and duration), topography (i.e. decreased area for less tolerant tree species), and biotic communities in the Project area. Sedimentation and altered hydrology have reduced areas of deep water overwintering habitat and acreage of island habitat. The structure of the floodplain forest, overall health, and sustainability (i.e. reproduction and recruitment) have been significantly affected through an increase in the amount of water and length of time water is present on areas that have historically contained flood-intolerant wetland tree species. As a result, flood-tolerant tree species (i.e. willows and silver maples) have colonized much of the Project area. The combination of stressors continue to degrade and decrease aquatic and wetland structure and function in the complex. While these factors will remain across the planning horizon, the Project provides a unique opportunity to increase quality, diversity, and sustainability of bottomland forest, floodplain, island, and aquatic habitats.

Slide 6: A unique feature for this Project is the pollinator habitat. Pollinator species, such as bees, butterflies, and hummingbirds, are indicators of ecosystem health and provide benefits to habitat diversity. Pollinators are currently in decline due to habitat loss and intensive farming practices; however, the UMR brings benefit to the pollinators, such as being used as a migration path for monarch butterflies. In the Midwest, the federally-listed endangered rusty-patched bumblebee and the candidate species monarch butterfly are two species that have acquired attention. The Project has the opportunity to incorporate pollinator species habitat that produce attractants vital to pollinator conservation. This would affect composition of seed mixes, but not add significant additional cost.

Slide 10: The data used for the CEICA analysis implies a high level of confidence, but there is a specific reason behind the numbers that were used for cost and output. Instead of rounding the costs and habitat units, the PDT wanted to keep the specifics to see how the Flow Diversity, Grant Slough complex, and SE Island features would fare in cost effectiveness and benefits. The CEICA showed us that the small amount of benefit that the Flow Diversity feature brought to its alternatives was cost effective but NOT a Best Buy. The alternatives that contained the SE Island feature were Best Buys, but only if Grant Slough were included. Depending on if and how we had rounded all the numbers, the differences between the alternatives relative to cost and benefit would not have been evident and alternatives would have been screened in a less calculated manner.

6. Questions During IPR:

a. MVD: Since higher water elevations are listed as a problem, shouldn’t a pool drawdown be considered as a feature?

MVR: A pool drawdown was on the initial measures list, but was screened from further consideration. The lock and dam system has increased water levels in the pools, which impacts floodplain forest growth and recruitment (i.e., drowning non-tolerant wetland trees) and replacing over time to more tolerant willows and maples. In addition, sedimentation in the backwaters has increased as a result in increased water inundation. A measure such as water level management isn’t effective or efficient for this Project due to the limited applicability of the feature measure and will not address the problems present within Steamboat Island. Topographic diversity (placing dredged material to raise elevation and planting trees on the raised area) gets the trees to a higher elevation, reducing the impact of increased water elevation. Screening of a water level management measure will be clearly described in the Report.

b. MVD: Is the Sponsor willing to fund operation and maintenance of the stone at the head of Steamboat Island?

MVR: USFWS is supportive of the feature and we are working through cost concerns with them.

c. MVD: What is the cost per habitat unit (and is cost typically $2-3K/unit)? With the high cost of the Project, the benefits seem low.

MVR: The $2-3K reference has historically referred to cost per acre and is a general frame of reference based on historic estimates. The estimated Project first cost (~$41,232,000) cannot be compared to the estimated Average Annual Habitat Units (~75), as those two items are not measured the same. Project first cost is not annualized and the net gain of 75 AAHUs is annualized. We do not have final cost per habitat unit or cost per acre right now, as we are finalizing the TSP and adjusting costs and benefits as we increase the level of detail on the TSP. We are confident in the final ranking of alternatives and selection of the TSP is justified. We understand the need to fully capture the ecological benefits of the Project and will investigate quantification of benefits to the fullest extent. In addition, some ecological significant aspects of the Project (e.g., biodiversity, contribution to limiting habitat, ecological connectivity, Essential Habitat Area quality, and restoration of island/wetland mosaic complex reflective of historic areas) are difficult to quantify through traditional methods. The significance of the outputs from the Project will be qualitatively described in detail to tell the whole story of the Project and how it contributes to ecological structure and function in Pool 14 and the broader UMRS. We recognize MVD's concern with the cost. The Project may result in a larger area than most HREPs, is worth the added investment and has support from the UMRR Regional Program Manager (Marshall Plumley), Partner (Iowa DNR), and Sponsor (USFWS) for the TSP. Previous HREP monitoring has showed that O&M cost for rock structures is low, as long as the rock is appropriately sized and located.

7. Action Item
   a. MVR will provide MFR of IPR meeting for review by April 18, 2019.

8. The MVR point of contact is Ms. Erica Stephens, [redacted], or email: [redacted]

Dennis W. Hamilton

Dennis W. Hamilton, P.E., P.M.P.
Chief, Programs and Project
Management Division

Enclosure:
Steamboat Island HREP IPR April 2019 MFR Attachments.pdf",
UMRR Steamboat Island HREP IPR slide deck, 11 April 2019

2016 Results of Unionid Mussel Monitoring near Quad Cities Nuclear Station, Mississippi River Miles 495 to 515

Prepared for:

Exelon Generation Company
Warrenville, IL

Prepared by:

Ecological Specialists, Inc.
O'Fallon, Missouri
an EcoAnalysts company

May 2017

(ESI Project #16-013)

1.0 Introduction

Exelon Generation (Exelon) requested alternate thermal standards pursuant to Section 316(a) of the Clean Water Act from the Illinois Pollution Control Board for its Quad Cities Nuclear Station (QCNS), which they received in July 2015 along with renewal of their National Pollutant Discharge Elimination System (NPDES) permit. Freshwater unionid mussel (unionid) beds harboring federal, Iowa, and/or Illinois threatened and endangered (T&E) species *Lampsilis higginsii*, *Plethobasus cyphyus*, *Ellipsaria lineolata*, *Ligumia recta*, *Pleurobema sintoxia*, *Lampsilis teres*, and *Strophitus undulatus* occur upstream and downstream of the QCNS. Additionally, the Cordova Essential Habitat Area (EHA) for *Lampsilis higginsii* occurs downstream and the Hansons Slough EHA occurs upstream of the QCNS plant (USFWS, 2008). In 2004, Exelon established a monitoring program for freshwater unionids near the QCNS thermal discharge diffuser. The purpose of the monitoring program was to provide data and information regarding the unionid community, to evaluate the effects QCNS discharge has had on the community, and to compare community characteristics observed following the approval of alternate thermal standards to the baseline unionid community characteristics.

Three unionid beds occur within 3500 m (approximately 2 river miles) of the QCNS thermal diffuser: the Steamboat Slough (SS) Bed, located approximately 675 to 1125 meters (m) downstream of the QCNS mixing zone; the Upstream (UP) Bed, located approximately 730 to 1130 m upstream of the QCNS diffuser; and the Cordova Bed, located about 3300 to 3700 m downstream of QCNS (Figure 1-1). Ecological Specialists, Inc. (ESI) monitored each of these unionid beds in 2004, 2005, 2006, 2007, 2008, and 2012. In 2007, the monitoring program added 400 m sections of 3 additional beds to further evaluate unionid community characteristics among and within unionid beds. The 3 additions were: the Albany Bed, located approximately 14,000 to 14,400 m upstream of the diffuser; the Hansons Slough (HS) Bed, located approximately 5000 to 5400 m upstream of the diffuser; and the Woodwards Grove (WG) Bed, located approximately 10,500 to 10,900 m downstream of the diffuser (Figure 1-1). All 6 beds were sampled in 2007, 2008, and 2012.

QCNS currently operates under NPDES permit conditions that allow 219 (2.5%) exclusion hours per year, during which the plant may cause river temperatures to exceed maximum temperature standards by up to 3° F, except during July, August, and September, the temperature standards may be exceeded by up to 5° F for no more than 131.4 hours of the annual 219-hour allotment. Prior to July 2015, QCNS operated under NPDES permit conditions that allowed 87.6 (1%) excursion hours per year, during which the plant may cause rivet temperatures to exceed maximum temperature standards by up to 3° F. QCNS operated within these permit conditions between 2000 and 2016, except for 2006 and 2012. Less than the allotted 87.6 excursion hours were used in 2001 (57.35 hours), 2005 (42.50 hours), 2007 (74.00 hours), 2009 (5.00 hours), 2010 (36.00 hours), and 2011 (33.00 hours; Table 1-1). No excursion hours were used between 2013 and 2016. In 2006 and 2012, QCNS was granted provisional variances from these permit conditions that allowed additional excursion hours at temperatures up to 5° F. The provisional variances were granted to address periods of low Mississippi River flows and high ambient river temperatures experienced in the summer of 2006 and in the spring and summer of 2012. QCNS used 222.75 (2.5%) excursion hours in 2006, and water temperature during excursion hour events exceeded maximum temperature standards by up to 5°F**.** Similar conditions (low river flows and/or high river temperatures) occurred in the spring and summer of 2012. QCNS used 442.50 (5.1%) excursion hours in 2012.

The Exelon mussel bed monitoring program specifies that monitoring will be conducted in years when excursion hours exceed the allotted 87.6 excursion hours or if monitoring has not occurred for 4 years. 2016 met the latter condition since excursion hours were not exceeded from 2013 – 2016. Monitoring was conducted at all 6 mussel beds near QCNS in 2016. This report presents the results of the 2016 monitoring activities and compares results with previous years.

2.0 Sampling and Analytical Methods

The Albany, Hansons Slough, Upstream, Steamboat Slough, Cordova, and Woodwards Grove beds (Table 2-1) were sampled between October 25 and November 3, 2016, using the same methods ESI used in 2007, 2008, and 2012 (ESI, 2013). Density, age distribution, and observed mortality were estimated using quantitative sampling methods. Species richness was estimated from qualitative samples. The extent of infestation by zebra mussels (*Dreissena polymorpha*) in the beds was also observed and recorded during monitoring events.

At each of the 6 sites, 90 0.25m^2 quantitative quadrat samples were collected. Sampling locations in each bed were randomly selected using GIS, and points were plotted on a Trimble Juno GPS. Samples were obtained from each location by a diver who excavated all substrate material from the quadrat to a depth of 15 cm into a 6-mm mesh bag. A surface crew retrieved the bag and rinsed material through 12 mm and 6 mm sieves. Substrate and debris were searched and unionids removed. All live unionids were identified to species, measured (length in millimeters [mm]), aged (external annuli count), and returned to the river. Freshly dead shells (FD; dead within the past year, nacre shiny, hinge flexible, valves attached, with or without tissue) were identified, counted, and classified as young unionids (Ambleminae ≤5 years old; Lampsilinae and Anodontinae ≤3 years old) or adults. Weathered shells (WD; dead many months to years, nacre chalky, hinge brittle, valves typically separated, periostracum intact) and subfossil shells (SF; dead many years to decades, periostracum eroded, valves separate, very chalky) were noted as present. Water depths (pneumometer) were recorded for each sample location. Substrate composition was estimated using a modified pebble count (Wolman, 1954). The substrate particle category (Wentworth scale) was recorded for each corner and the center of each quadrat (90 x 5 = 450 substrate observations per site). The percentage of each substrate category was calculated for each site.

The qualitative sampling approach was designed to collect as many individuals as possible, thereby increasing the probability of finding rare species (Kovalak et al., 1986). For each qualitative sample, a diver searched for and collected unionids for 5-minute intervals at 25 locations spread throughout each bed. All live and fresh shells of unionids were identified, designated as adults or young unionids, and counted. Live unionids were returned to the river. The position of each qualitative sample was recorded with a Trimble Juno GPS. Bottom water temperature, dissolved oxygen (DO) levels, and current velocity (meters/second) were recorded at each location.

Data regarding the mussel bed community characteristics were analyzed using Analysis of Variance methodology (ANOVA). The following parameters were analyzed: differences in total, young and adult density; differences in Ambleminae and Lampsilinae density; and differences in density of freshly dead shells based on sampling dates and bed location. The data were log (x+1) transformed for ANOVAs and significance level was $p<0.05$ for all tests. Bonferroni post-hoc tests were used to detect differences among dates within each site. Regression analysis was used to determine the slope (rate of increase) of species with respect to cumulative individuals, using the equation: cumulative species = slope * log (cumulative individuals). The intercept constant was set to zero, as no species are present if no individuals are collected. Rarefaction species richness (number of species based on an equal number of individuals) was calculated to compare species richness among years. EstimateS v9.1.0 (Colwell, 2013) was used to calculate rarefaction richness.

3.0 Results and Discussion

3.1 River Flow Rates and Water Temperatures

River flow was relatively high in 2016. Average monthly flow in August and September 2016 was higher than all previous monitoring years and October was higher than all but 2010 (Figure 3-1). Ambient river temperatures were relatively normal in 2016 and no excursion hours were used.

3.2 Upstream Beds

3.2.1 Albany Bed

Albany Bed was the upstream-most bed sampled. The bed extends upstream from Albany, IL (near RM 513) to Cattail Slough (near RM 516). Although very long, the bed is narrow, extending an average of only about 40 m from the bank into the river. The widest portion of the bed (about 70 m wide) was within the town of Albany, IL, near RM 513 and was selected for sampling (Figure 1-1). Land use along the riverbank is residential, and the bank is lined with rip-rap.

The Albany Bed was most similar to the Cordova Bed in habitat characteristics. Substrate was primarily zebra mussel shells mixed with gravel and sand (Table 3-1). Zebra shell increased while cobble and sand decreased in 2016, but this may be due to sample location rather than habitat change, as the values seem to be within the range of previous years (Table 3-2). As in previous years, zebra mussel shells were still a significant substrate component, particularly near the riverward edge of the bed. Depth within the bed ranged from 1.5 to 6.1 m, and DO (8.5 to 8.9 mg/L) was consistent with other sites at the time of sampling (Table 3-1). Similar to 2012, water temperature was relatively low (range 52.9 to 53.5°F), as sampling was conducted in late October. Water temperature in the Albany Bed was generally consistent with other sites. Current velocity (0 to 0.7 m/sec) was higher than previous years due to high water conditions in 2016. No zebra mussel infestation was observed in 2016, which was a decline from 2008 to 2012 (11.2 and 3.8 zebra mussels/unionid in 2008 and 2012, respectively), but was similar to 2007 (0.1 zebra mussels/unionid), and was comparable to the low infestation rates observed in 2016 at other sites (Tables 3-1 and 3-2).

Since habitat was similar between the Albany and Cordova beds, the unionids communities should be similar unless other factors were affecting community characteristics. The Albany Bed unionid community was most like the Cordova Bed community. *Amblema p. plicata* was the dominant species in both beds, Lampsilinae and Ambleminae were similar in abundance, and relative abundance of most species was similar (Table 3-3). However, *Quadrula p. pustulosa* (10.0%) and *Truncilla donaciformis* (11.3%) appeared more abundant in the Albany Bed (5.6% and 3.0%, respectively, Cordova Bed), and *Leptodea fragilis* (15.4%) was more abundant in the Cordova Bed than in the Albany Bed ((4.9%); Table 3-3). Both beds contained the live threatened or endangered species (T&E species) *L. recta*, *L. higginsii*, *E. lineolata*, and *S. undulatus* (Table 3-3). *Ligumia recta* were more abundant in the Albany and Cordova beds than in the other beds in this monitoring study. *Lampsilis teres* (found in the Albany bed in 2012) was collected live in the Cordova bed in 2016.

Density did not differ significantly between Cordova and Albany beds for live unionids, adults, young, Ambleminae, Lampsilinae, or freshly dead unionids (Table 3-4). Species richness regression slopes were 8.17 and 7.58, respectively,

3.3 Downstream Beds

3.3.1 Steamboat Slough Bed

The SS Bed is located approximately 750 m downstream of the QCNS mixing zone (Figure 1-1). Substrate in the SS Bed consisted of sand and silt, with some clay also present in 2016. While silt typically comprised 25-50% of the substrate in previous years, it was not a significant component of the substrate in 2016. Water depth ranged from 0.9 to 4.3 m and averaged 2.3 m (Table 3-18). Current velocity has varied from 0 (August 2006) to 0.6 m/sec (July 2004) and in 2016 ranged from 0.2 to 0.5 m/sec. Dissolved oxygen ranged from a low of 5.1 mg/L in August 2006 to a high of 12.8 mg/L in July 2005. In 2016, DO averaged 8.3 mg/L and was similar to DO in other unionid beds downstream of the QCNS facility (Table 3-1). Very few zebra mussels were found in the SS Bed in previous monitoring events. However, zebra mussel infestation was higher in 2016 than in previous years, and was the highest of all beds sampled in 2016. Water temperature ranged from 53.1 to 53.6°F and was consistent with declining water temperatures throughout the 2016 study period.

The SS Bed continues to support a less dense and less species rich unionid community than the UP Bed, although dominant species were similar between the 2 beds. *Obliquaria reflexa* (25.0%) was the most frequently encountered species in 2016, followed by *Quadrula quadrula* (20.5%), a species which has increased in abundance in the past 2 monitoring events. *Amblema plicata* and *Quadrula p. pustulosa* (18.2% each) were also commonly encountered (Table 3-19). One new species, *Quadrula metanevra,* was collected in 2016.

Density in the SS Bed has been relatively consistent in prior years. Density in 2016 (2.0 unionids/m^2) was lower than in all previous monitoring events, but was not significantly different from density in July 2004 or August 2008 (Table 3-20). Ambleminae continue to comprise a higher percent of the community than Lampsilinae (63.4% vs. 34.6%), and overall, Ambleminae density (1.3/m^2) was significantly greater than Lampsilinae (0.6/m^2) density. Ambleminae density was significantly higher than Lampsilinae density in 2008, 2012, and 2016, but did not differ from Lampsilinae density in previous years (Table 3-20). Density of total live adults, total live young, live Ambleminae, Ambleminae adults and young, live Lampsilinae, and Lampsilinae adults and young have all fluctuated over time (significantly higher or lower in some monitoring events), but no increasing or decreasing trends were apparent. No significant differences were detected in density of fresh dead unionids (total, Lampsilinae, or Ambleminae) in the SS Bed among monitoring years. Mortality was ≤10% overall as well as for both Amblemines and Lampsilines, and was consistent with mortality in previous years. Overall recruitment has fluctuated over the years, but was relatively low (20.8%) in 2016. On average, though, the SS Bed tends to have lower recruitment than most other beds in the study. Ambleminae recruitment (21.2%) was similar to previous years, but Lampsilinae recruitment was notably lower (7.1%) than in previous years. Similar declines in Lampsilinae recruitment were observed in several other beds in 2016.

Age of unionids collected in quantitative samples ranged from 2 to 24 years old (Table 3-21). Four of the 6 Ambleminae species were represented by young individuals. Although no Ambleminae juveniles ≤3 years old were collected in quantitative samples in 2012, several individuals in this age class were present in 2016. Only 2 of the 5 Lampsilinae species were represented by young individuals, and only 1 individual ≤3 years old was collected.

T&E species occurred at a very low frequency in the SS Bed, with only a few individuals collected in any year and/or only sporadically collected (Table 3-19). *Ligumia recta* have been consistently collected in the last 7 monitoring events. *Pleurobema sintoxia* was collected in August 2006 and October 2007. *Ellipsaria lineolata* were found in July 2004 and 2005, but have not been collected since. *Lampsilis teres* was only found alive in 2007 and 2012, and all individuals collected in 2012 were 0-1 years old. Two individuals of *Lampsilis higginsii*, previously thought to not occur in the SS Bed, were found in the SS Bed in 2008; however, no *L. higginsii* have been collected since.

3.3.2 Cordova Bed

The Cordova Bed is one of the Essential Habitat Areas designated in the *L. higginsii* recovery plan (USFWS, 2004). This bed has historically harbored a dense and diverse unionid community. However, density within this bed has declined in recent years primarily due to heavy zebra mussel infestation. The portion of the Cordova Bed sampled in this study is approximately 3300 m downstream of QCNS mixing zone, on the Illinois bank of the river (Figure 1-1).

Zebra mussels were more abundant in the Cordova Bed than other beds during most past monitoring events. In 1994, zebra mussel density in the Cordova bed was <10/m^2 (Miller and Payne, 1995). In 1999, most unionids in the Cordova Bed had <50 zebra mussels attached. By 2000, zebra mussels encrusted all unionids and covered the substrate in most of the Cordova Bed. In 2001, few zebra mussels were found within 20 m of the bank, but density further from the bank averaged 3000 to 4000/m^2. However, in 2002, zebra mussels declined appreciably and only one-third of the unionids had a few zebra mussels attached. Zebra mussel density in 2003 had declined to <1000/m^2. Zebra mussel density increased in the Cordova Bed in 2004; however, density declined in 2005 and remained low in 2006 and 2007 (Table 3-22). Infestation was very high in 2008 and then declined appreciably in later sampling years; no unionids were infested with zebra mussels in 2016 (Table 3-22). Zebra mussel infestation in the Cordova Bed was comparable to the Albany and Hansons Slough Beds in 2016.

Zebra mussel infestation has resulted in high unionid mortality and reduced density within the Cordova Bed. Before heavy zebra mussel infestation (1994), density in the Cordova Bed ranged from 51 to 83 unionids/m^2 and recruitment (measured as percentage of unionids ≤30 mm) ranged from 10 to 49% (Miller and Payne, 1996). In 1999, zebra mussel density was extremely high, unionid mortality was near 50%, and recruitment was near zero at RM 504.3 (ESI, 1999). Between 2001 and 2003, zebra mussel density declined, unionid density and recruitment increased, and mortality declined. Density in 2002 and 2003 ranged from 3.6 to 8.1 unionids/m^2 and, in 2003, recruitment was near 44% (Farr et al., 2002; ERDC, 2003 preliminary data). Unionid density and recruitment have remained stable since 2004, with density averaging 4.7 unionids/m^2 and percentage young unionids averaging 31.8% (Table 3-23). Strayer and Malcolm (2007) also noted a dramatic decline in unionid density in the Hudson River following zebra mussel infestation, followed by a lower density unionid community coexisting with zebra mussels for several years until other invasive species affected unionid abundance (blue crabs that were feeding on zebra mussels, shifted to juvenile unionids when zebra mussels declined; Strayer, personal communication, 2017).

The Cordova Bed differs from the UP and SS beds in that it occurs along a slight outside bend in the river, and its substrate has been coarser (higher percentages of gravel, cobble, shell; Table 3-1). Substrate in 2016 was similar to previous years, and still contained a relatively high percentage of zebra mussel shells. Depth ranged from 0.1 to 7.3 m over all monitoring events, and averaged 3.1 m in 2016. Dissolved oxygen in the Cordova Bed was similar to previous years, averaging 8.3 mg/L (range, 8.2 to 8.6 mg/L; Table 3-22). Current velocity (average, 0.5 m/sec) was higher than in previous years, perhaps due to high discharge during sampling. Water temperature in 2016 was consistent with declining water temperatures throughout the study period, and ranged from 55.0 to 55.8°F.

Species composition and relative abundance in the Cordova Bed were similar to the Albany Bed, and similar trends in unionid community characteristics were observed at both sites. Average relative abundance of Ambleminae (46.3%) and Lampsilinae (48.5%) in this bed was fairly equal (Table 3-24). As in all prior monitoring events, *A. plicata* (33.7%) dominated the community in 2016. *Quadrula p. pustulosa* appeared to be declining somewhat in this bed, but relative abundance of this species was higher in 2016 (12.2%) than in all previous years. Recruitment was markedly lower (11.2%) in 2016 than in all previous monitoring events. Species richness was similar to previous years (20 species collected in 2016), and the slope of the species richness curve remained consistent. Total density and density of adults and juveniles all fluctuated throughout monitoring events, with no apparent increasing or decreasing trends, though juvenile density was significantly lower in 2016 than in 2012. Density of fresh dead shells and overall mortality were lower than in previous monitoring events, as no mortality was observed in 2016 (Table 3-23).

Characteristics specific to Ambleminae and Lampsilinae were similar between the Cordova Bed and the Albany Bed in 2012. Density of total Ambleminae, total Lampsilinae, Ambleminae adults and juveniles, and Lampsilinae adults and juveniles fluctuated throughout monitoring events, with no apparent increasing or decreasing trends, as did density of fresh dead shells and overall mortality. No mortality was observed in either subfamily. Recruitment of both Ambleminae (7.7%) and Lampsilinae (2.4%) was the lowest recorded in all monitoring events thus far; however, recruitment was relatively low in several other beds as well. Density of Ambleminae and Lampsilinae did not differ in 2016 (Table 3-23).

Age of unionids collected in quantitative samples from the Cordova Bed ranged from 1 to 28 years old (Table 3-25). Only 2 of the 5 Ambleminae species and 3 of the 10 Lampsilinae species in this bed were represented by young individuals. The majority of juveniles collected were *Quadrula p. pustulosa*, a species previously thought to be declining somewhat in this bed.

Threatened and endangered species, including *E. lineolata, L. recta,* and *L. higginsii,* continue to be collected regularly from the Cordova Bed. All 3 of these species were present in 2016. *Ligumia recta* and *L. higginsii* have been collected in all monitoring events, while *E. lineolata* has only been collected since 2005. *Lampsilis teres*, not previously collected

4.0 Conclusions

Community characteristics within unionid mussel beds upstream and downstream of the QCNS diffuser discharge have fluctuated over time, but these beds continue to support low to moderate density, species rich unionid communities. The monitoring program focused on unionid beds with similar habitat characteristics upstream and downstream of the diffuser; Cordova (downstream) was most similar to Albany (Upstream), Steamboat Slough (downstream) had similar characteristics to both UP and Hanson Slough beds (upstream). Characteristics of all of these communities varied slightly from previous monitoring events, and some significant differences among years were observed. However, no consistent increasing or decreasing trends were apparent when all monitoring years were considered. Rather, characteristics observed in 2016 were similar to previous monitoring events and likely reflect natural fluctuations. Recruitment appeared to be lower in some of the beds than in previous years, but this may be due to higher water levels in the last few years, as recruitment of many species seems to be lower during high water years.

Results of this study also show that community characteristics within the beds sampled in this study do not seem to be significantly affected by the QCNS thermal effluent. Unionid beds downstream of the QCNS exhibited similarities and differences in habitat and unionid community characteristics with unionid beds upstream of the QCNS, and no significant trends were observed that distinguished the downstream beds from the upstream beds.

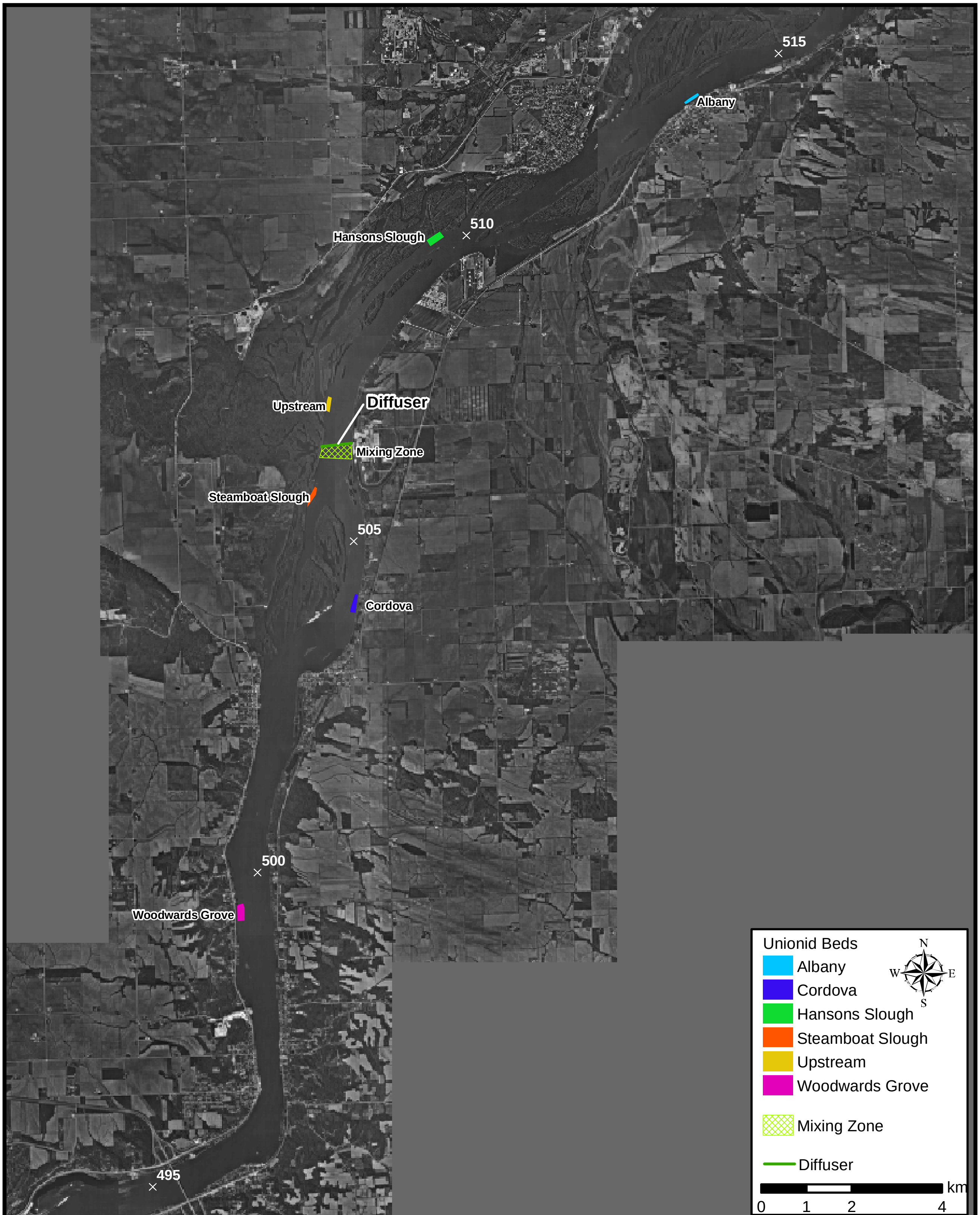


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Figure 1-1. Unionid bed monitoring areas near QCNS, 2004 through 2016.

Table 2-1. Unionid sample sites within the QCNS study area, 2004 to 2016.

Site	MRM	Sample area (m)	Distance from diffuser (km)	Sample dates								
				Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16
Albany Bed	513.5	400 x 70	14.0 -14.8						x	x	x	x
Hansons Slough (HS)	509.5	400 x 150	5.0 - 5.4						x	x	x	x
Upstream Bed (UP)	507.0	400 x 80	0.7 - 1.1	x	x	x	x	x	x	x	x	x
Steamboat Slough Bed (SS)	505.6	400 x 50	0.9 - 1.3	x	x	x	x	x	x	x	x	x
Cordova Bed	504.0	400 x 100	3.3 - 3.7	x	x	x	x	x	x	x	x	x
Woodwards Grove Bed (WG)	499.5	400 x 150	10.5 - 10.9						x	x	x	x

MRM= Mississippi River Mile

Table 3-1. Comparison of habitat conditions among unionid beds sampled in October 2016.

	Upstream Beds			Downstream Beds		
	Albany	HS	UP	SS	Cordova	WG
Sample date	Oct 27, 28, 31	Oct 25, 31	Oct 25, 27, 28, Nov 3	Oct 28, Nov 2	Oct 29, Nov 1	Oct 30, Nov 1
Discharge (cfs)[1]	93,807 to 98,771	87,775 to 98,771	87,775 to 97,592	96,878 to 97,327	97,592 to 98,231	98,231 to 98,963
Dist from bank (m)	10 to 70	10 to 150	45 to 115	35 to 115	10 to 90	10 to 150
Dist from mix zone (m)	14,000 to 14,400	5,000 to 5,400	730 to 1,130	675 to 1,125	3,030 to 3,365	10,500 to 10,900
Substrate						
% Bedrock	8	0	0	0	0	0
% Boulder	3	0	0	0	6	0
% Cobble	9	0	0	1	3	1
% Gravel	11	0	0	0	24	0
% Sand	14	70	60	87	14	58
% Silt	5	20	1	0	11	7
% Clay	5	8	32	12	6	15
% Detritus	0	0	0	0	0	0
% Shell	45	1	5	0	37	18
% Vegetation	0	0	0	0	0	0
Depth (m)						
Ave.	3.6	2.2	4.8	3.2	3.1	4.3
Range	(1.5 to 6.1)	(0.6 to 3.7)	(2.1 to 7.6)	(1.8 to 3.9)	(1.2 to 7.3)	(1.5 to 7.6)
CV[2]	33.0	29.0	28.0	15.0	34.0	26.0
Bottom temp (°F)						
Ave.	53.2	53.7	54.8	53.4	55.5	55.6
Range	(52.9 to 53.5)	(53.6 to 53.8)	(54.4 to 54.9)	(53.1 to 53.6)	(55.0 to 55.8)	(55.2 to 55.8)
CV[2]	0.8	0.3	0.5	0.6	0.7	0.5
Bottom DO (mg/L)						
% saturation	83.1	87.5	83.9	78.6	80.7	80.7
Ave.	8.8	9.2	8.7	8.3	8.3	8.3
Range	(8.5 to 8.9)	(8.9 to 9.6)	(7.7 to 8.9)	(8.2 to 8.4)	(8.2 to 8.6)	(7.9 to 8.4)
CV[2]	1.2	2.4	2.4	0.6	1.0	1.4
Bottom current velocity (m/sec)						
Ave.	0.5	0.4	0.5	0.4	0.5	0.4
Range	(>0 to 0.7)	(0.2 to 0.5)	(0.4 to 0.5)	(0.2 to 0.5)	(0.3 to 0.7)	(0.1 to 0.5)
CV[2]	26.0	19.0	7.0	24.0	23.0	23.0
Rel. zebra mussel inf.[3]	0.0	0.0	0.4 (0 - 10)	6.8 (0 - 10)	0.0	0.6 (0 - 10)

[1]Lock and Dam 14 (LeClaire, IA; MRM 493.3)

[2]CV = coefficient of variation (Standard deviation*100/mean)

[3]Average and range of zebra mussels per unionid

Table 3-3. Comparison of average species relative abundance (%)[1] among unionid beds upstream and downstream of QCNS.

	Upstream beds			Downstream beds		
	Albany[2]	HS[2]	UP[3]	SS[3]	Cordova[3]	WG[2]
Margaritiferidae						
Cumberlandia monodonta	**SF**	**-**	**-**	**-**	**-**	**-**
Ambleminae						
Amblema plicata	21.4	18.9	22.2	27.7	34.2	15.2
Cyclonaias tuberculata	**WD**	**-**	**SF**	**-**	**SF**	**SF**
Elliptio crassidens	**SF**	**-**	**-**	**-**	**-**	**-**
Elliptio dilatata	**SF**	**-**	**-**	**-**	**SF**	**WD**
Fusconaia ebena	WD	-	WD	WD	WD	WD
Fusconaia flava	3.6	5.1	5.2	2.8	2.1	0.4
Megalonaias nervosa	1.7	0.1	0.4	X	2.4	3.8
Plethobasus cyphyus	**SF**	**-**	**-**	**-**	**P**	**SF**
Pleurobema sintoxia	**SF**	**0.2**	**WD**	**X**	**WD**	**X**
Quadrula metanevra	X	X	0.1	X	WD	SF
Quadrula nodulata	0.5	3.8	1.2	11.3	0.3	6.1
Quadrula p. pustulosa	10.0	35.1	8.2	7.7	5.6	2.8
Quadrula quadrula	4.3	5.7	6.8	13.8	1.7	25.6
Tritogonia verrucosa	**SF**	**-**	**WD**	**WD**	**WD**	**WD**
Total Ambleminae	41.4	68.8	44.1	63.4	46.3	53.8
Anodontinae						
Anodonta suborbiculata	-	-	-	-	-	X
Arcidens confragosus	0.5	X	0.4	0.5	0.5	1.4
Lasmigona c. complanata	1.4	0.2	1.6	0.8	0.6	1.2
Lasmigona costata	-	-	-	-	-	SF
Pyganodon grandis	1.2	0.2	0.2	3.8	1.5	1.2
Strophitus undulatus	**0.2**	**WD**	**WD**	**-**	**0.1**	**-**
Utterbackia imbecillis	2.6	WD	0.5	FD	2.5	7.7
Total Anodontinae	5.9	0.4	2.7	2.0	5.1	11.6
Lampsilinae						
Actinonaias ligamentina	WD	0.1	X	X	0.3	SF
Ellipsaria lineolata	**0.5**	**1.7**	**0.5**	**0.3**	**0.4**	**0.4**
Lampsilis cardium	8.2	7.8	7.2	2.9	8.2	1.5
Lampsilis higginsii	**1.3**	**0.3**	**0.1**	**X**	**2.0**	**0.2**
Lampsilis ovata	-	-	X	-	-	-
Lampsilis siliquoidea	SF	-	-	-	0.1	-
Lampsilis teres	**0.3**	**X**	**0.5**	**0.5**	**WD**	**0.3**
Leptodea fragilis	4.9	0.8	5.8	1.7	15.4	8.9
Ligumia recta	**7.5**	**0.9**	**0.9**	**0.2**	**4.3**	**0.4**
Obliquaria reflexa	12.7	14.5	29.4	21.9	7.5	12.7
Obovaria olivaria	1.8	1.6	2.7	0.6	0.3	0.2
Potamilus alatus	1.1	0.2	0.4	0.5	1.7	2.1
Potamilus capax	**-**	**-**	**WD**	**-**	**-**	**-**
Potamilus ohiensis	0.2	1.0	1.1	3.5	0.6	2.9
Toxolasma parvus	2.6	0.2	0.3	0.1	2.6	0.3
Truncilla donaciformis	11.3	1.4	3.8	2.2	3.0	6.4
Truncilla truncata	0.3	0.3	0.5	0.1	0.5	0.2
Total Lampsilinae	52.7	30.8	53.1	34.6	48.5	36.6
No. species live/FD	25	25	26	26	26	25
Total species	35	27	32	28	33	33
No. live/FD T&E species	5	5	4	5	5	5
Total no. T&E species	11	6	9	6	10	9

[1]Numbers represent % that species represents in quantitative samples. X=not collected in quantitative samples, but found in qualitative samples

[2]Average of October 2007, August 2008, and October 2012

[3]Average of all monitoring events 2004 to 2016

FD = freshly dead shell, WD = weathered shell, SF = subfossil shell, P=collected in a recent study by ILDNR (D. Sallee, pers. com)

Bold indicates Illinois, Iowa and Federally threatened and endangered species

Table 3-4. Comparison of average community characteristics among unionid beds upstream and downstream of QCNS.

	Upstream beds			Downstream beds		
	Albany[4]	HS[4]	UP[5]	SS[5]	Cordova[5]	WG[4]
Total no.[1]	404	1082	735	557	436	905
Ave. no./m[2,2]	5.3 ± 0.8A	8.3 ± 1.3B	9.9 ± 1.1B	4.1 ± 0.4A	4.7 ± 0.5A	8.8 ± 1.2B
Ave. CPUE [3]	10.0	32.2	25.5	21.8	15.2	24.8
Ave. no. species/qual sample[3]	5.1	7.1	6.9	6.2	5.9	7.0
Total no. live/FD species[1]	20.5	20.3	21.6	16.2	20.3	22.3
Cumulative live/FD species	25	25	26	26	25	25
Rarefaction species richness[3]						
100	17	11	13	10	15	14
250	20	15	17	14	19	18
500	21	18	20	16	20	20
750	-	20	22	16	-	22
Regression slope	8.17	6.30	7.32	5.64	7.58	7.49
Ave. no. young/m[2,2]	2.0 ± 0.4AC	2.1 ± 0.4AC	2.6 ± 0.4CD	0.9 ± 0.2B	1.6 ± 0.3A	3.6 ± 0.8D
Ave. no. adults/m[2,2]	3.1 ± 0.5A	6.1 ± 1.1B	7.0 ± 0.9B	3.1 ± 0.4A	3.1 ± 0.3A	4.8 ± 0.7B
% young[2]	40.6	22.4	29.4	22.1	31.8	41.6
% of species w/ ≤5 yrs[2]	64.0	66.8	69.1	58.6	60.5	66.6
Ave. no. FD/m[2,2]	0.5 ± 0.2A	0.4 ± 0.2AB	0.6 ± 0.1A	0.2 ± 0.1B	0.5 ± 0.2A	0.3 ± 0.1AB
%Mortality[2]	8.8	5.1	4.9	3.6	12.1	2.8
% adult mortality[2]	10.7	6.6	6.1	4.4	11.8	6.0
% juvenile mortality[2]	6.6	1.0	7.5	2.8	12.6	0.9
Ambleminae						
Total no. [2]	50.0	127.8	84.6	48.1	39.2	95.8
Total no. [1]	152.8	597.5	259.0	334.1	205.4	436.0
Ave. no./m[2,2]	2.2 ± 0.4A*	5.7 ± 0.9BC*	4.6 ± 0.6C*	2.6 ± 0.3A*	2.1 ± 0.3A*	4.3 ± 0.6BC*
Ave. no.≤5yrs/m[2,2]	0.7 ± 0.2A	1.5 ± 0.3B	1.3 ± 0.2B	0.6 ± 0.1A	0.5 ± 0.1A	1.3 ± 0.3B
Ave. no.>5yrs/m[2,2]	1.6 ± 0.4A	4.2 ± 0.8B	3.2 ± 0.5CD	2.0 ± 0.3AC	1.6 ± 0.2A	3.0 ± 0.5BD
% young[2]	29.7	22.9	28.6	23.2	26.0	30.3
Total no. species[1]	5.8	6.8	5.9	5.4	5.4	6.3
Total no. species w/young[1]	4.3	5.0	5.1	4.4	4.1	5.5
Total no. adult species[1]	5.8	6.3	5.7	5.4	5.2	6.3
Ave. no. FD/m[2,2]	0.2 ± 0.1AB	0.3 ± 0.1B	0.1 ± 0.1AB	0.1 ± 0.0A	0.2 ± 0.1AB	0.0 ± 0.1A
%Mortality[2]	9.2	4.9	2.4	2.2	8.8	1.1
% adult mortality[2]	6.5	5.4	2.9	1.9	5.9	1.7
% juvenile mortality[2]	8.2	0.0	3.6	1.4	17.9	0.0
Lampsilinae						
Total no. [2]	63.5	56.5	94.0	26.4	43.3	73.3
Total no. [1]	124.5	265.3	294.3	159.4	125.9	161.8
Ave. no./m[2,2]	2.8 ± 0.5A#	2.5 ± 0.5A#	5.1 ± 0.6C#	1.4 ± 0.2B#	2.3 ± 0.3A*	3.3 ± 0.6A#
Ave. no.≤3yrs/m[2,2]	1.3 ± 0.3AD	0.6 ± 0.2BC	1.4 ± 0.2D	0.3 ± 0.1C	0.9 ± 0.2AB	1.8 ± 0.5D
Ave. no.>3yrs/m[2,2]	1.6 ± 0.3AB	1.9 ± 0.4A	3.6 ± 0.5C	1.1 ± 0.2B	1.4 ± 0.2AB	1.4 ± 0.3AB
% young[2]	39.3	19.4	29.4	20.3	33.5	48.5
Total no. species[1]	10.0	10.5	11.6	8.2	10.9	11.8
Total no. species w/young[1]	7.3	6.0	8.6	4.7	6.1	7.5
Total no. adult species[1]	8.8	9.0	10.0	7.3	10.0	10.5
Ave. no. FD/m[2,2]	0.3 ± 0.1AB	0.2 ± 0.1AB	0.4 ± 0.1B	0.1 ± 0.0A	0.3 ± 0.1AB	0.1 ± 0.1AB
%Mortality[2]	7.6	5.2	6.0	5.4	13.1	4.3
% adult mortality[2]	15.4	8.3	7.4	8.2	13.4	12.8
% juvenile mortality[2]	5.0	6.7	11.5	2.4	8.6	0.0

[1]Quantitative and Qualitative combined; [2]Quantitative data only; [3]Qualitative data only

[4]Average of October 2007, August 2008, October 2012, and October 2016

[5]Average of all monitoring events 2004 to 2016

Different letters within a row indicates a significant difference (ANOVA, $p<0.05$)

Different symbols within a column indicate a significant difference (t-test, $p\leq0.05$)

Table 3-13. Comparison of community characteristics among unionid beds upstream and downstream of QCNS, 2016.

	Upstream beds			Downstream beds		
	Albany	HS	UP	SS	Cordova	WG
Total no.[1]	208	457	673	313	342	445
Ave. no./m[2,2]	3.5 ± 1.0A	3.4 ± 1.2A	11.2 ± 3.4B	2.0 ± 0.7A	4.4 ± 1.2AC	7.6 ± 2.1BC
Ave. CPUE [3]	5.2	15.2	16.8	10.7	9.8	11.0
Ave. no. species/qual sample[3]	3.1	4.8	4.5	4.3	5.0	4.8
Total no. live/FD species[1]	18	15	20	14	20	21
Cumulative live/FD species	25	25	26	26	25	25
Rarefaction species richness[3]						
100	16	10	13	9	15	14
250	-	13	17	13	19	18
500	-	-	19	-	-	-
750	-	-	-	-	-	-
Regression slope	7.76	5.37	7.10	5.08	7.72	7.61
Regression slope - 95% CI	7.11 - 8.41	3.60 - 7.13	5.98 - 8.21	3.39 - 6.76	6.42 - 9.03	6.26 - 8.96
Ave. no. young/m[2,2]	1.0 ± 0.5A	0.2 ± 0.2A	2.2 ± 1.0A	0.4 ± 0.3A	0.5 ± 0.3A	1.7 ± 0.6A
Ave. no. adults/m[2,2]	2.4 ± 0.8AB	3.2 ± 1.2ABC	9.1 ± 3.1C	1.6 ± 0.6AC	3.9 ± 1.0ABC	5.9 ± 1.8C
% young[2]	29.1	5.2	19.4	20.8	11.2	22.8
% of species w/ ≤5 yrs[2]	50.0	26.7	60.0	42.9	31.6	52.4
Ave. no. FD/m[2,2]	0.3 ± 0.2A	0.2 ± 0.2AB	0.0 ± 0.1AB	0.0 ± 0.1AB	0.0 ± 0.0B	0.0 ± 0.1AB
%Mortality[2]	8.2	4.9	0.4	2.2	0.0	0.6
% adult mortality[2]	-	-	-	-	-	-
% juvenile mortality[2]	-	-	-	-	-	-
<u>Ambleminae</u>						
Total no. [2]	29	51	142	30	52	112
Total no. [1]	67	228	211	221	126	188
Ave. no./m[2,2]	1.3 ± 0.5A*	2.3 ± 0.8A*	6.3 ± 2.3B*	1.3 ± 0.6A*	2.3 ± 0.7A*	5.0 ± 1.4B*
Ave. no.≤5yrs/m[2,2]	0.3 ± 0.2AB	0.1 ± 0.1B	0.6 ± 0.4AB	0.3 ± 0.3B	0.2 ± 0.2B	0.8 ± 0.4A
Ave. no.>5yrs/m[2,2]	1.0 ± 0.4AB	2.2 ± 0.8B	5.7 ± 2.2AB	1.1 ± 0.5B	2.1 ± 0.7B	4.2 ± 1.3A
% young[2]	24.1	3.9	9.2	21.2	7.7	16.1
Total no. species[1]	6	7	6	6	5	6
Total no. species w/young[1]	3	1	4	4	2	4
Total no. adult species[1]	6	7	6	6	5	6
Ave. no. FD/m[2,2]	0.3 ± 0.2A	0.2 ± 0.2AB	0.0 ± 0.1AB	0.0 ± 0.1AB	0.0 ± 0.0B	0.0 ± 0.1AB
%Mortality[2]	17.1	7.3	0.7	3.2	0.0	0.9
% adult mortality[2]	-	-	-	-	-	-
% juvenile mortality[2]	-	-	-	-	-	-
<u>Lampsilinae</u>						
Total no. [2]	41	26	104	13	41	47
Total no. [1]	44	151	196	90	102	73
Ave. no./m[2,2]	1.8 ± 0.7AB#	1.2 ± 0.6AB#	4.6 ± 1.4C#	0.6 ± 0.3B#	1.9 ± 0.6A*	2.1 ± 0.8AB#
Ave. no.≤3yrs/m[2,2]	0.5 ± 0.3A	0.1 ± 0.1A	1.6 ± 0.7B	0.1 ± 0.2A	0.2 ± 0.2A	0.6 ± 0.3A
Ave. no.>3yrs/m[2,2]	1.3 ± 0.5ABC	1.1 ± 0.6AC	3.0 ± 1.2B	0.4 ± 0.3C	1.6 ± 0.6AB	1.5 ± 0.7ABC
% young[2]	4.8	3.8	24.0	7.1	2.4	12.8
Total no. species[1]	8	7	11	6	10	11
Total no. species w/young[1]	5	3	8	2	3	6
Total no. adult species[1]	7	6	10	5	10	11
Ave. no. FD/m[2,2]	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
%Mortality[2]	0.0	0.0	0.0	0.0	0.0	0.0
% adult mortality[2]	-	-	-	-	-	-
% juvenile mortality[2]	-	-	-	-	-	-

[1]Quantitative and Qualitative combined; [2]Quantitative data only; [3]Qualitative data only
Different letters within a row indicates a significant difference (ANOVA, p<0.05)
Different symbols within a column indicate a significant difference (t-test, p≤0.05)

Table 3-18. Comparison of SS Bed habitat conditions between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016.

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Sample date	July 16, 2004	July 26-28, 2005	Oct 5-6, 2005	Aug 4-5, 2006	Sept 20-24, 2006	Oct 5-13, 2007	Aug 20-23, 2008	Oct. 31-Nov. 1, 2012	Oct 28, Nov 2	
Discharge (cfs)[1]	65,969	39,203 to 41,262	54,383 to 52,887	27,695 to 35,189	21,257 to 30,178	56,600 to 77,700	27,594 to 33,497	26,878 to 26,994	96,878 to 97,327	
Substrate temp N end	-	-	-	88.0 to 87.4	-	62.0 to 70.1	80.0 to 82.0	-	-	
Substrate temp S end	-	-	-	88.0 to 87.1	-	61.4 to 70.1	80.2 to 83.5	-	-	
Dist from bank (m)	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	
Dist from mix zone (m)	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	
<u>Substrate</u>										
% Boulder	0	0	2	0	0	0	1	0	0	<1
% Cobble	<1	0	0	0	0	0	2	0	0	<1
% Gravel	<1	0	0	0	0	0	1	0	1	<1
% Sand	90	91	95	69	71	49	55	49	87	73
% Silt	6	9	3	23	26	49	39	51	0	23
% Clay	3	<1	0	6	2	1	1	0	12	3
% Detritus	<1	1	0	2	1	1	1	0	0	<1
% Shell	0	0	<1	0	0	0	0	0	0	<1
<u>Depth (m)</u>										
Ave.	2.4	1.8	2.7	2.0	2.1	1.9	2.5	2.2	3.2	2.3
Range	(1.7 to 3.7)	(0.9 to 2.7)	(0.9 to 4.3)	(1.2 to 3.4)	(1.2 to 3.3)	(0.9 to 3.4)	(1.5 to 3.0)	(1.5 to 3.0)	(1.8 to 3.9)	
CV[2]	24	20	74	32	18	25	15	15	15	
<u>Bottom temp (°F)</u>										
Ave.	79.7	85.1	71.1	88.0	66.4	60.8	80.3	52.0	53.4	70.7
Range	(77.0 to 80.6)	(81.5 to 86.0)	(69.4 to 73.2)	(87.4 to 88.7)	(64.6 to 67.1)	60.8	(78.8 to 80.6)	(51.1 to 53.2)	(53.1 to 53.6)	
CV[2]	1.2	3.0	4.4	0.6	1.3	0.0	0.8	1.2	0.6	
<u>Bottom DO (mg/L)</u>										
% saturation	83.3	119.3	92.2	146.5	91.8	84.1	100.0	112.6	78.6	
Ave.	6.7	9.1	8.1	10.9	8.5	8.3	8.0	12.1	8.3	8.9
Range	(6.4 to 7.4)	(7.5 to 12.8)	(7.8 to 8.9)	(5.1 to 12.0)	(7.9 to 9.5)	(7.6 to 9.0)	(7.8 to 8.2)	(11.8 to 12.5)	(8.2 to 8.4)	
CV[2]	10.9	20.7	3.1	14.0	4.0	5.3	1.4	1.2	0.6	
<u>Bottom current velocity (m/sec)</u>										
Ave.	0.4	0.2	0.3	<0.1	0.1	0.2	0.1	0.1	0.4	0.2
Range	(0.2 to 0.6)	(0.1 to 0.3)	(0.1 to 0.5)	(0 to 0.2)	(0.1 to 0.2)	(0.1 to 0.4)	(>0 to 0.2)	(>0 to 0.2)	(0.2 to 0.5)	
CV[2]	16	21	31	185	23	226	37	48	24.0	
Rel. zebra mussel inf.[3]	Minor	0.1 (0 to 1)	0.1 (0 to 10)	0.0	0.02 (0 to 1)	0.01 (0 to 1)	0.1 (0 to 2)	0.7 (0 to 12)	6.8 (0 to 10)	1.0

[1]Lock and Dam 14 (LeClaire, IA; MRM 493.3)

[2]CV = coefficient of variation (Standard deviation*100/mean)

[3]Minor = a few zebra mussels attached to a few unionids; 2005, 2006, 2007, 2008, 2012 average and range of zebra mussels per unionid

Table 3-19. Comparison of SS Bed unionid relative abundance (%) between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016[1].

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Ambleminae										
Amblema plicata	41.5	26.8	30.9	32.2	22.3	22.6	26.8	28.2	18.2	27.7
Fusconaia ebena	-	-	-	-	-	-	SF	WD	-	WD
Fusconaia flava	X	9.8	2.1	1.1	3.2	2.2	4.9	X	2.3	2.8
Megalonaias nervosa	-	-	-	-	-	X	-	-	-	X
Pleurobema sintoxia	**-**	**-**	**-**	**X**	**-**	**X**	**-**	**-**	**-**	**X**
Quadrula metanevra	-	-	-	-	-	-	-	-	X	X
Quadrula nodulata	9.8	2.4	6.4	11.1	13.8	16.1	17.1	15.5	9.1	11.3
Quadrula p. pustulosa	4.9	7.3	5.3	4.4	3.2	10.8	4.9	10.7	18.2	7.7
Quadrula quadrula	4.9	14.6	17.0	12.2	11.7	9.7	13.4	20.4	20.5	13.8
Tritogonia verrucosa	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**WD**	-	**WD**
Total Ambleminae	61.1	61.0	61.7	61.1	54.3	61.3	67.1	74.8	68.3	63.4
Anodontinae										
Arcidens confragosus	X	2.4	X	-	-	-	-	X	2.3	0.5
Lasmigona c. complanata	2.4	X	X	X	1.1	1.1	2.4	X	X	0.8
Pyganodon grandis	X	2.4	X	1.1	FD	X	2.4	WD	-	3.8
Utterbackia imbecillis	-	X	X		FD	-	-	-	-	FD
Total Anodontinae	2.4	4.9	0.0	1.1	1.1	1.1	4.9	0.0	2.3	2.0
Lampsilinae										
Actinonaias ligamentina	-	-	-	-	X	-	-	-	-	X
Ellipsaria lineolata	**2.4**	**X**	**-**	**-**	**-**	**-**	**WD**	**-**	**-**	**0.3**
Lampsilis cardium	4.9	X	5.3	4.4	7.4	2.2	X	1.9	X	2.9
Lampsilis higginsii	**-**	**-**	**-**	**-**	**-**	**-**	**X**	**-**	**-**	**X**
Lampsilis teres	**-**	**-**	**X**	**-**	**-**	**X**	**WD**	**4.9**	**-**	**0.5**
Leptodea fragilis	X	2.4	4.3	2.2	3.2	-	1.2	1.9	X	1.7
Ligumia recta	**-**	**-**	**1.1**	**X**	**1.1**	**X**	**X**	**X**	**X**	**0.2**
Obliquaria reflexa	26.8	22.0	22.3	23.3	19.1	28.0	18.3	12.6	25.0	21.9
Obovaria olivaria	2.4	-	X	X	2.1	X	X	1.0	-	0.6
Potamilus alatus	-	-	X	1.1	-	1.1	-	X	2.3	0.5
Potamilus ohiensis	X	7.3	3.2	4.4	7.4	3.2	3.7	-	2.3	3.5
Toxolasma parvus	-	-	WD	-	-	-	-	1.0	-	0.1
Truncilla donaciformis	-	2.4	2.1	2.2	4.3	2.2	4.9	1.9	-	2.2
Truncilla truncata	-	X	X	-	-	1.1	WD	-	-	0.1
Total Lampsilinae	36.5	34.1	38.3	37.8	44.7	37.6	28.0	25.2	29.6	34.6

[1]Numbers represent % that species represents in quantitative samples. X=not collected in quantitative samples, but found in qualitative samples
FD = freshly dead shell, WD = weathered shell, SF = subfossil shell
Bold indicates Illinois, Iowa and Federally threatened and endangered species

Table 3-20. Comparison of SS bed unionid community characteristics between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016.

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Total no.[1]	547	426	657	398	537	546	712	875	313	557
Ave. no./m^2[2]	3.4±2.0AC	4.1±1.2AB	4.2±0.9A	9.0±2.6B	4.2±1.0A	4.1±1.0A	3.6±1.0AC	4.6±1.3A	2.0±0.7C	4.1 ± 0.4
Ave. CPUE [3]	36.1	19.3	22.5	15.4	17.7	18.1	25.2	30.9	10.7	21.8
Ave. no. species/qual sample[3]	7.7	5.6	7.2	6.0	6.3	6.8	6.2	6.1	4.3	6.2
Total no. live/FD species[1]	15	16	19	16	16	18	15	17	14	16.2
Cumulative live/FD species	15	18	20	21	22	23	24	25	26	26
Rarefaction species richness[3]										
100	10	10	12	11	11	12	10	9	9	10
250	14	14	16	15	13	15	13	13	13	14
500	15	-	18	-	14	18	14	15	-	16
750	-	-	-	-	-	-	-	16	-	16
Regression slope	5.48	5.56	6.55	5.97	5.32	6.24	5.22	5.35	5.08	5.64
Regression slope - 95% CI	4.79 - 6.16	4.09 - 7.02	5.37 - 7.73	3.76 - 8.19	4.92 - 5.71	4.23 - 8.26	4.15 - 6.29	4.52 - 6.18	3.39 - 6.76	
Ave. no. young/m^2[2]	0.2 ±0.2A	0.4±0.4AC	0.4 ±0.2A	1.8±0.8B	1.5±0.5BC	1.3±0.5BC	1.8±0.6B	0.8±0.4ABC	0.4±0.3A	0.9 ± 0.2
Ave. no. adults/m^2[2]	3.3 ±1.9AC	3.7±1.2AB	3.8 ±0.9B	7.2±2.3B	2.7±0.8A	2.8±0.8AC	1.9±0.7AC	3.7±1.2AB	1.6±0.6C	3.1 ± 0.4
% young[2]	4.9	9.8	8.5	20.0	35.1	32.3	48.8	18.4	20.8	22.1
% of species w/ ≤5 yrs[2]	33.3	41.7	63.6	66.7	84.6	55.6	66.7	72.7	42.9	58.6
Ave. no. FD/m^2[2]	0.2 ±0.2A	0.1 ±0.2A	0.1 ±0.2A	0.1±0.2A	0.5±0.3A	0.1±0.1A	0.1±0.2A	0.2±0.2A	0.0±0.1A	0.2 ± 0.1
%Mortality[2]	4.7	2.4	3.1	1.1	8.7	2.1	3.5	4.6	2.2	3.6
% adult mortality[2]	-	-	-	1.4	9.0	1.6	4.5	5.6	-	4.4
% young mortality[2]	-	-	-	0.0	8.3	3.2	2.4	0.0	-	2.8
Ambleminae										
Total no. [2]	25	25	58	55	51	57	55	77	30	48.1
Total no. [1]	335	259	347	207	275	287	541	565	221	337.4
Ave. no./m^2[2]	2.1±1.4AC*	2.5±1.0ABC*	2.6±0.7ABC*	5.5±2.2B*	2.3±0.7AC*	2.5±0.7ABC*	2.4±0.8ABC*	3.4±1.0AB*	1.3±0.6C*	2.6 ± 0.3*
Ave. no.≤5yrs/m^2[2]	0.2±0.2AB	0.2±0.3AB	0.2±0.2A	1.2±0.7BC	0.8±0.4ABC	1.1±0.5BC	1.3±0.5C	0.4±0.3AB	0.3±0.3AB	0.6 ± 0.1
Ave. no.>5yrs/m^2[2]	1.9±1.3AB	2.3±1.0AB	2.4±0.7AB	4.3±1.9B	1.5±0.6A	1.4±0.5A	1.2±0.6A	3.0±1.0AB	1.1±0.5A	2.0 ± 0.3
% young[2]	8.0	8.0	6.9	21.8	33.3	43.9	52.7	13.0	21.2	23.2
Total no. species[1]	5	5	5	6	5	7	5	5	6	5.4
Total no. species w/young[1]	5	4	4	4	5	5	5	4	4	4.4
Total no. adult species[1]	5	5	5	6	5	7	5	5	6	5.4
Ave. no. FD/m^2[2]	0.1±0.2A	0.0±0.0A	0.0±0.1A	0.1±0.2A	0.0±0.1A	0.0±0.1A	0.0±0.1A	0.1±0.2A	0.0±0.1A	0.1 ± 0.0
%Mortality[2]	3.8	0.0	1.7	1.8	1.9	1.7	1.8	3.8	3.2	2.2
% adult mortality[2]	-	-	-	2.3	2.9	0.0	0.0	4.3	-	1.9
% young mortality[2]	-	-	-	0.0	0.0	3.8	3.3	0.0	-	1.4
Lampsilinae										
Total no. [2]	15	14	36	34	42	35	23	26	13	26.4
Total no.[1]	163	123	197	99	265	152	161	198	90	160.9
Ave. no./m^2[2]	1.3±0.9BC*	1.4±0.8ABC*	1.6±0.6ABC*	3.4±1.3A*	1.9±0.7AB*	1.6±0.6BC*	1.0±0.5BC#	1.2±0.5BC#	0.6±0.3C#	1.4 ± 0.2#
Ave. no.≤3yrs/m^2[2]	0.0±0.0A	0.2±0.3A	0.2±0.2A	0.6±0.5A	0.7±0.4A	0.2±0.2A	0.5±0.3A	0.4±0.3A	0.1±0.2A	0.3 ± 0.1
Ave. no.>3yrs/m^2[2]	1.3±0.9AB	1.2±0.7AB	1.4±0.6AB	2.8±1.3A	1.2±0.5AB	1.3±0.5AB	0.5±0.3B	0.8±0.4AB	0.4±0.3AB	1.1 ± 0.2
% young[2]	0.0	14.3	11.1	17.6	35.7	14.3	47.8	34.6	7.1	20.3
Total no. species[1]	9	7	10	8	8	9	8	9	6	8.2
Total no. species w/young[1]	7	3	5	6	6	4	4	5	2	4.7
Total no. adult species[1]	7	7	10	6	8	8	8	7	5	7.3
Ave. no. FD/m^2[2]	0.1±0.2A	0.1±0.2A	0.1±0.1A	0.0±0.0A	0.3±0.2A	0.0±0.1A	0.1±0.1A	0.1±0.1A	0.0±0.1A	0.1 ± 0.0
%Mortality[2]	6.3	6.7	5.3	0.0	12.5	2.8	8.0	7.1	0.0	5.4
% adult mortality[2]	-	-	-	0.0	12.9	3.2	14.3	10.5	-	8.2
% young mortality[2]	-	-	-	0.0	11.8	0.0	0.0	0.0	-	2.4

[1]Quantitative and Qualitative combined; [2]Quantitative data only; [3]Qualitative data only; Species richness includes preliminary samples in 2004
Different letters within a row indicates a significant difference (ANOVA, p<0.05)
Different symbols within a column indicates a significant difference (t-test; p<0.10)

Table 3-21. Age (external annuli count) frequency of unionid species collected in the SS Bed, October 2016.

Subfamily	Species	Young[2]	Age (external annuli count)[1] 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	24	Total
Ambleminae	*Amblema plicata*	Y	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	2	1	-	1	8
	Fusconaia flava	N	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
	Quadrula metanevra	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Quadrula nodulata	Y	1	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	4
	Quadrula p. pustulosa	Y	-	1	-	-	1	1	1	-	-	-	-	1	-	1	2	-	-	-	-	8
	Quadrula quadrula	Y	1	1	-	1	1	-	-	-	-	-	1	2	-	-	1	-	-	1	-	9
Ambleminae Total			2	3	0	1	2	2	1	0	0	0	2	7	0	1	4	2	1	1	1	30
Anodontinae	*Arcidens confragosus*	N	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
	Lasmigona c. complanata	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Anodontinae Total			0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Lampsilinae	*Lampsilis cardium*	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Leptodea fragilis	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Ligumia recta	**N**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Obliquaria reflexa	Y	-	-	1	1	-	1	1	-	-	-	3	2	-	1	-	1	-	-	-	11
	Potamilus alatus	N	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	Potamilus ohiensis	Y	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Lampsilinae Total			1	0	1	1	0	2	1	0	0	0	3	2	0	1	0	1	0	0	0	13
Total			3	3	1	2	2	4	2	0	0	0	5	9	0	3	4	3	1	1	1	44

Bold indicates Illinois, Iowa, and Federally threatened and endangered species

[1]Quantitative samples only

[2]All sample methods

Table 3-22. Comparison of Cordova Bed habitat conditions between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016.

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Sample date	Jul 13-14, 2004	July 27, 2006	Oct 3-4, 2005	Aug 3-4, 2006	Sept 20-24, 2006	Oct 6-12, 2007	Aug 19-25, 2008	Oct. 28-29, 2012	Oct 29, Nov 1	
Discharge (cfs)[1]	72,916 to 69,220	38,153	47,125 to 52,245	18,544 to 27,695	21,257 to 30,178	67,300 to 77,700	27,439 to 33,497	26,697 to 26,704	97,592 to 98,231	
Substrate temp N end	-	-	-	-	-	60.8 to 69.3	76.6 to 80.4	-	-	
Substrate temp S end	-	-	-	-	-	61.0 to 69.0	77.1 to 81.0	-	-	
Dist from bank (m)	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	
Dist from mix zone (m)	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	
Substrate										
% Boulder	<1	3	2	0	0	3	2	3	6	2
% Cobble	2	0	1	<1	<1	<1	3	4	3	2
% Gravel	13	6	10	13	8	15	29	28	24	16
% Sand	33	77	66	40	43	17	23	23	14	37
% Silt	27	6	9	9	21	19	19	24	11	16
% Clay	13	0	0	19	7	1	5	0	6	6
% Detritus	<1	0	<1	0	<1	<1	2	0	0	<1
% Shell	12	8	13	18	18	44	13	16	37	20
% Vegetation	0	0	0	<1	1	1	4	0	0	1
Depth (m)										
Ave.	2.0	2.1	3.0	1.7	2.2	1.6	2.5	2.5	3.1	2.3
Range	(0.6 to 3.4)	(1.2 to 3.7)	(0.6 to 6.7)	(0.6 to 3.0)	(0.1 to 6.4)	(0.9 to 2.7)	(0.6 to 4.6)	(0.6 to 6.1)	(1.2 to 7.3)	
CV[2]	28	86	147	45	57	32	44	56	34	
Bottom temp (°F)										
Ave.	77.5	77.5	65.5	87.3	64.2	60.9	78.3	51.2	55.5	68.7
Range	(73.4 to 79.3)	(73.4 to 80.2)	(54.0 to 67.1)	(85.6 to 89.1)	(63.9 to 65.3)	(60.9 to 61.7)	(77.0 to 79.9)	(50.5 to 53.1)	(55.0 to 55.8)	
CV[2]	0.6	5.9	5.3	2.8	1.0	0.9	0.8	1.3	0.7	
Bottom DO (mg/L)										
% saturation	73.1	-	88.2	87.5	82.4	85.1	114.8	108.8	80.7	
Ave.	6.0	-	8.3	8.5	7.8	8.4	9.3	12.1	8.3	8.6
Range	(5.7 to 6.6)	-	(7.2 to 14.0)	(7.7 to 9.6)	(4.3 to 18.1)	(8.0 to 8.6)	(8.4 to 13.9)	(11.5 to 12.7)	(8.2 to 8.6)	
CV[2]	12.6	-	3.7	7.3	55.6	1.7	16.6	3.2	1.0	
Bottom current velocity (m/sec)										
Ave.	0.2	0.2	0.2	<0.1	0.1	0.2	<0.1	<0.1	0.5	4.0
Range	(0.1 to 0.4)	(0.1 to 0.3)	(0.1 to 0.5)	(0.0 to 0.2)	(>0.0 to 0.1)	(0.0 to 0.4)	(0.0 to 0.1)	(0.0 to 0.1)	(0.3 to 0.7)	
CV[2]	48	42	54	127	52	71	79	87	23	
Rel. zebra mussel inf.[3]	Very heavy	0.3 (0 to 5)	1.3 (0 to 50)	0.1 (0 to 20)	0.3 (0 to 12)	0.01 (0 to 1)	16.4 (0 to 100+)	3.1 (0 to 25)	0.0	2.7

[1]Lock and Dam 14 (LeClaire, IA; MRM 493.3)

[2]CV=coefficient of variation (Standard deviation*100/mean)

[3]Very heavy=most unionids coated or encased with zebra mussels; 2005, 2006, 2007, 2008, 2012 average and range of zebra mussels per unionid

Table 3-23. Comparison of Cordova Bed unionid community characteristics between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016.

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Total no.[1]	320	164	375	430	745	651	455	438	342	436
Ave. no./m^2[2]	5.7±1.9ABC	3.0±1.3AC	5.8±1.5AB	3.7±1.4ABC	3.0±1.1C	4.7±1.2ABC	4.6±1.0ABC	6.8±1.4B	4.4±1.2ABC	4.7 ± 0.5
Ave. CPUE [3]	15.8	6.7	10.2	19.7	27.1	21.8	14.1	11.4	9.8	15.2
Ave. no. species/qual sample[3]	6.6	3.3	5.1	7.4	7.5	7.6	5.8	5.2	5.0	5.9
Total no. live/FD species[1]	20	18	21	19	20	23	22	20	20	20.3
Cumulative live/FD species	20	20	22	23	24	25	25	25	25	25
Rarefaction species richness[3]										
100	15	15	16	15	13	15	15	16	15	15
250	19	-	19	18	16	19	19	19	19	19
500	-	-	-	-	18	22	-	-	-	20
750	-	-	-	-	-	-	-	-	-	-
Regression slope	7.76	7.20	7.89	7.36	6.58	7.91	7.96	7.82	7.72	7.58
Regression slope - 95% CI	5.96 - 9.56	6.18 - 8.22	5.66 - 10.13	5.33 - 9.39	5.13 - 8.03	6.21 - 9.61	6.19 - 9.73	7.45 - 8.19	6.42 - 9.03	
Ave. no. young/m^2[2]	2.2±1.0AC	0.6 ±0.5AB	2.1 ±0.9A	1.1±0.6AB	0.8±0.4AB	1.6±0.7A	2.0±0.6AC	3.5±1.0C	0.5±0.3B	1.6 ± 0.3
Ave. no. adults/m^2[2]	3.5 ±1.4A	2.4±1.2A	3.7 ±0.9A	2.6±1.3A	2.2±0.9A	3.0±0.9A	2.6±0.7A	3.3±0.9A	3.9±1.0A	3.1 ± 0.3
% young[2]	33.8	20.0	36.2	29.7	25.4	35.2	43.7	51.0	11.2	31.8
% of species w/ ≤5 yrs[2]	53.8	55.6	61.1	62.5	71.4	69.6	63.6	75.0	31.6	60.5
Ave. no. FD/m^2[2]	1.8 ±1.6AB	0.8 ±0.9AB	0.2±0.2B	0.6±0.5AB	1.4±0.6A	0.2±0.2B	0.2±0.2B	0.4±0.6B	0.0±0.0B	0.5 ± 0.2
%Mortality[2]	24.4	21.1	3.0	14.0	31.6	3.7	4.6	6.1	0.0	12.1
% adult mortality[2]	-	-	-	13.3	31.5	2.9	4.9	6.3	-	11.8
% juvenile mortality[2]	-	-	-	15.4	32.0	5.1	4.3	6.0	-	12.6
<u>Ambleminae</u>										
Total no. [2]	27	18	51	15	33	48	57	52	52	39.2
Total no. [1]	120	79	151	221	497	304	211	140	126	205.4
Ave. no./m^2[2]	2.3±1.1A*	1.8±1.1A*	2.3±0.8A*	1.5±0.8A*	1.5±0.7A*	2.1±0.8A*	2.5±0.7A*	2.3±0.7A*	2.3±0.7A*	2.1 ± 0.3*
Ave. no.≤5yrs/m^2[2]	0.8±0.6A	0.5±0.4A	0.5±0.4A	0.5±0.4A	0.4±0.3A	0.5±0.3A	1.0±0.5A	0.4±0.3A	0.2±0.2A	0.5 ± 0.1
Ave. no.>5yrs/m^2[2]	1.5±0.8A	1.3±1.0A	1.8±0.7A	1.0±0.6A	1.1±0.6A	1.6±0.7A	1.5±0.6A	1.9±0.7A	2.1±0.7A	1.6 ± 0.2
% young[2]	33.3	27.8	21.6	33.3	27.3	25.0	40.4	17.3	7.7	26.0
Total no. species[1]	6	5	5	6	5	6	6	5	5	5.4
Total no. species w/young[1]	4	2	4	6	5	6	4	4	2	4.1
Total no. adult species[1]	6	5	5	5	5	5	6	5	5	5.2
Ave. no. FD/m^2[2]	0.3±0.3A	0.3±0.5A	0.2±0.2A	0.2±0.3A	0.3±0.3A	0.1±0.2A	0.1±0.1A	0.2±0.4A	0.0±0.0A	0.2 ± 0.1
%Mortality[2]	10.0	14.3	7.3	11.8	17.5	5.9	3.4	8.8	0.0	8.8
% adult mortality[2]	-	-	-	9.1	7.7	5.3	2.9	4.4	-	5.9
% juvenile mortality[2]	-	-	-	16.7	35.7	7.7	4.2	25.0	-	17.9
<u>Lampsilinae</u>										
Total no. [2]	40	11	74	18	33	55	44	74	41	43.3
Total no. [1]	116	50	72	147	147	164	221	114	102	125.9
Ave. no./m^2[2]	3.3±1.2AB*	1.1±0.6A*	3.3±1.0AB*	1.8±0.9AB*	1.5±0.6A*	2.4±0.8AB*	2.0±0.6AB*	3.3±0.7B#	1.9±0.6AB*	2.3 ± 0.3*
Ave. no.≤3yrs/m^2[2]	1.4±0.7AB	0.1±0.2B	1.6±0.7A	0.5±0.4B	0.4±0.2B	1.1±0.5AB	0.9±0.4AB	2.0±0.6A	0.2±0.2B	0.9 ± 0.2
Ave. no.>3yrs/m^2[2]	1.9±0.8A	1.0±0.6A	1.7±0.6A	1.3±0.8A	1.1±0.5A	1.4±0.5A	1.1 ±0.4A	1.3±0.5A	1.6±0.6A	1.4 ± 0.2
% young[2]	42.5	9.1	47.3	27.8	24.2	43.6	45.5	59.5	2.4	33.5
Total no. species[1]	11	9	12	10	10	13	12	11	10	10.9
Total no. species w/young[1]	8	4	4	7	6	7	8	8	3	6.1
Total no. adult species[1]	9	9	12	10	9	12	11	8	10	10.0
Ave. no. FD/m^2[2]	1.5±1.2A	0.4±0.5AB	0.0±0.0B	0.2±0.3AB	0.9±0.5A	0.0±0.1B	0.1±0.1B	0.2±0.3B	0.0±0.0B	0.3 ± 0.1
%Mortality[2]	31.0	26.7	0.0	10.0	38.9	1.8	4.3	5.1	0.0	13.1
% adult mortality[2]	-	-	-	7.1	43.2	0.0	7.7	9.1	-	13.4
% juvenile mortality[2]	-	-	-	16.7	20.0	4.0	0.0	2.2	-	8.6

[1]Quantitative and Qualitative combined; [2]Quantitative data only; [3]Qualitative data only

Different letters within a row indicates a significant difference (ANOVA, $p<0.05$)

Different symbols within a column indicate a significant difference (t-test, $p≤0.05$)

Table 3-24. Comparison of Cordova Bed unionid relative abundance (%) between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016[1].

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Ambleminae										
Amblema plicata	27.9	50.0	24.6	27.0	35.8	33.3	46.6	28.8	33.7	34.2
Cyclonaias tuberculata	**-**	**-**	**-**	**-**	**-**	**-**	**SF**	**SF**	**-**	**SF**
Elliptio dilatata	**-**	**-**	**-**	**-**	**-**	**-**	**SF**	**-**	**-**	**SF**
Fusconaia ebena	WD	-	-	-	-	-	SF	SF	-	WD
Fusconaia flava	X	3.3	3.1	2.7	4.5	1.0	1.0	1.3	2.0	2.1
Megalonaias nervosa	2.9	X	4.6	2.7	4.5	1.9	1.0	2.0	2.0	2.4
Pleurobema sintoxia	**-**	**-**	**-**	**-**	**-**	**-**	**WD**	**SF**	**-**	**WD**
Quadrula metanevra	X	-	-	WD	-	-	SF	SF	-	SF
Quadrula nodulata	-	-	-	2.7	FD	X	X	WD	-	0.3
Quadrula p. pustulosa	5.9	6.7	4.6	2.7	4.5	7.6	4.9	1.3	12.2	5.6
Quadrula quadrula	2.9	X	2.3	2.7	X	1.9	1.9	0.7	3.1	1.7
Tritogonia verrucosa	**WD**	**-**	**WD**	**-**	**-**	**-**	**SF**	**-**	**-**	**WD**
Total Ambleminae	39.6	60.0	39.2	40.5	49.3	45.7	55.3	34.0	53.0	46.3
Anodontinae										
Arcidens confragosus	X	3.3	X	X	X	X	X	X	1.0	0.5
Lasmigona c. complanata	1.5	X	1.5	WD	1.5	X	X	X	1.0	0.6
Pyganodon grandis	X	X	0.8	8.1	X	X	1.0	3.3	X	1.5
Strophitus undulatus	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**SF**	**-**	**0.1**
Utterbackia imbecillis	X	FD	1.5	2.7	FD	1.0	1.0	14.4	2.0	2.5
Total Anodontinae	1.5	3.3	3.8	10.8	1.5	1.9	1.9	17.6	4.0	5.1
Lampsilinae										
Actinonaias ligamentina	X	-	-	-	1.5	1.0	-	SF	X	0.3
Ellipsaria lineolata	**WD**	**-**	**X**	**2.7**	**FD**	**X**	**X**	**1.3**	**X**	**0.4**
Lampsilis cardium	7.4	6.7	5.4	16.2	6.0	7.6	7.8	5.2	11.2	8.2
Lampsilis higginsii	**1.5**	**X**	**0.8**	**2.7**	**4.5**	**1.9**	**4.9**	**X**	**2.0**	**2.0**
Lampsilis siliquoidea	-	-	-	-	X	-	-	-	1.0	0.1
Lampsilis teres	**-**	**-**	**-**	**WD**	**-**	**-**	**WD**	**-**	**-**	**WD**
Leptodea fragilis	33.8	16.7	29.2	8.1	10.4	12.4	6.8	17.7	3.1	15.4
Ligumia recta	**1.5**	**X**	**6.2**	**5.4**	**7.5**	**2.9**	**2.9**	**3.9**	**8.2**	**4.3**
Obliquaria reflexa	8.8	3.3	6.9	5.4	-	8.6	8.7	11.1	14.3	7.5
Obovaria olivaria	X	X	0.8	X	-	X	1.9	X	X	0.3
Potamilus alatus	X	X	0.8	5.4	1.5	3.8	1.9	1.3	1.0	1.7
Potamilus ohiensis	1.5	3.3	X	-	-	X	X	0.7	-	0.6
Toxolasma parvus	1.5	6.7	3.8	FD	1.5	5.7	2.9	1.3	-	2.6
Truncilla donaciformis	2.9	-	2.3	X	1.5	8.6	3.9	5.9	2.0	3.0
Truncilla truncata	WD	-	0.8	2.7	WD	-	1.0	-	-	0.5
Total Lampsilinae	58.9	36.7	56.9	48.6	49.3	52.4	42.7	48.4	42.8	48.5

[1]Numbers represent % that species represents in quantitative samples. X=not collected in quantitative samples, but found in qualitative samples
FD = freshly dead shell, WD = weathered shell, SF = subfossil shell
Bold indicates Illinois, Iowa and Federally threatened and endangered species

Table 3-25. Age (external annuli count) frequency of unionid species collected in the Cordova Bed, October 2016.

			Age (external annuli count)[1]																							
Subfamily	Species	Young[2]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	28	Total
Ambleminae	*Amblema plicata*	Y	-	-	-	-	-	-	1	-	-	1	-	3	5	7	9	3	-	-	-	2	-	2	-	33
	Fusconaia flava	N	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	2
	Megalonaias nervosa	N	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
	Quadrula p. pustulosa	Y	-	-	1	2	1	-	1	1	-	-	2	1	1	-	1	1	-	-	-	-	-	-	-	12
	Quadrula quadrula	N	-	-	-	-	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	3
Ambleminae Total			0	0	1	2	1	1	3	2	0	1	3	4	7	8	10	4	0	0	0	2	0	2	1	52
Anodontinae	*Arcidens confragosus*	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
	Lasmigona c. complanata	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
	Pyganodon grandis	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Utterbackia imbecillis	Y	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Anodontinae Total			1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	4
Lampsilinae	***Ellipsaria lineolata***	**N**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	0
	Lampsilis cardium	N	-	-	-	-	-	-	1	2	1	-	-	2	2	-	1	1	1	-	-	-	-	-	-	11
	Lampsilis higginsii	**N**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	2
	Lampsilis siliquoidea	N	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
	Leptodea fragilis	Y	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
	Ligumia recta	**Y**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	7
	Obliquaria reflexa	Y	-	-	-	-	2	4	3	1	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	14
	Obovaria olivaria	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Potamilus alatus	N	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	Truncilla donaciformis	N	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Lampsilinae Total			0	1	0	1	2	7	5	4	3	0	3	3	3	0	4	2	1	0	0	0	1	1	0	41
Total			1	1	2	3	3	8	8	6	3	1	6	7	10	8	15	6	1	0	0	2	2	3	1	97

Bold indicates Illinois, Iowa, and Federally threatened and endangered species

[1]Quantitative samples only

[2]All sample methods

Memorandum for Record

Subject: Steamboat Island HREP Floodplain Modeling Discussion held on 12 September 2019

Present:
IADNR: Kelly Stone
USACE: Lucie Sawyer, Anton Stork, Shirley Johnson, Julie Millhollin, Rachel Perrine, Kyle Nerad

See "Steamboat Island HREP_IADNR_Floodplain_Call.pdf" slides and discussion below

Lucie introduced the Steamboat Island HREP (Project), Project Delivery Team (PDT), Project problems/objectives, and Tentatively Selected Plan (TSP).

Lucie explained the floodplain modeling accomplished so far and acknowledged the effective (2014) Flood Insurance Study (FIS) and (2011) Flood Insurance Rate Map (FIRM). Elevations from a "refined existing terrain" which utilized green LiDAR (Steamboat Island, Steamboat Slough), echo boat data (Grant Slough), and updated hydrosurvey in the main navigation channel were used to update the Effective Model (2004 Floodway Model) cross-section geometry. The With-Project geometry elevations were based off of a with-project terrain. Lucie showed the floodplain impacts due to the TSP Upper Steamboat Island (USI) restoration/protection measure. The Sponsor (USFWS) has been concerned about how we will ever be able to restore islands that have eroded and degraded in the Upper Mississippi River (UMR) with the given flood constraints. The Sponsor suggested we coordinate with MVP, who had gone through similar situations, and MVP suggested restoring the island to a footprint shown in a past FIS and FIRM.

Our proposal to use the 1993 FIRM footprint (as defined by the 1953 USGS 7.5 Min Quad Maps) for the USI restoration & protection design footprint was presented to Kelly. Elevations would be based on the 1991 7.5 Min Quad Map, as the 1953 map did not contain contours. The use of these maps further shows that the island did, historically, have a larger footprint than what is existing. The current (2011) FIRM and the historic (1993) FIRM show the same footprint for USI, which is much broader than what exists and is also broader than the USI as shown in the 2004 Effective Model. The 2004 Effective Model shows the USI to be broader than what currently exists but not as broad as the FIRM. This discussion illustrated the discrepancy between the way features are shown in the Effective FIRM Mapping and the Effective Modeling, which Kelly mentioned is often the case. He clarified that ultimately the Effective Model is considered the reference for comparison, not the FIRM.

Kelly inquired about other developments or manmade structures that would impact floodplain impacts in the Project area, as the 2004 Effective Model may not include structures or developments that communities may have constructed. The combination of degradation/erosion at the upstream end of Steamboat Island and further development in the watershed would impact floodplain modeling.

Kelly supports using Effective Model elevations prior to recent erosion occurring. Kelly recommends modeling the 2004 Effective Model (NOT with refined terrain) and with-Project in a 4-step series to see difference in each step (Effective, Corrected Effective, with Project, etc). Kelly, Shirley, and Lucie discussed how to use the 2004 Effective Model in the pool that has very inconsistent aggradation rates. Kelly recommended identifying where there has been deposition and choosing cross-section elevation sources that represent the deposited condition to include in the corrected effective (to avoid attributing depositional WSEL impacts to the With-Project). The modeling should be able to get back to no impact by filling back in where island has eroded. The 1993 FIRM footprint is not consistent enough to use; Kelly recommends relying more on the cross sections of the 2004 Effective Model (but not necessarily the 2004 footprint) to demonstrate no impacts due to island restoration.

Path Forward:

- Lucie model the Base Condition utilizing 2004 Effective Model cross-sections to show larger USI footprint and where appropriate use refined existing condition terrain and compare to TSP (With-Project).
- Tell the story of what happened and show how the data supports that story.

- If necessary, find other excavation that would increase flow conveyance to offset floodplain impacts (including channel maintenance activities in Project vicinity).
- Continue coordination and contact Kelly if more questions arise; request Kelly to review to Floodplain Permit in Joint Permit Application package.

Memorandum for Record

Subject: Steamboat Island HREP Floodplain Modeling Update & Iowa DNR Coordination

After incorporating the recommendations from Kelly Stone, Lucie was able to model the original TSP design of the USI restoration/protection measure and show “no rise”. Lucie sent information to Kelly with her methodology and results, including the “no rise” table, and requested confirmation that she was on the right path. During a phone call on 24 September, Kelly Stone recommended, based on the minimal review he was able to do, that we should move forward with the modeled results. He also informed Lucie that we will not need a floodplain permit issued from the State of Iowa, as the Project area contains 100% Federal land. We still need to show “no rise” and acquire a floodplain permit from the State of Illinois (“no rise” has already been demonstrated for Illinois standards).

Written by Rachel Perrine, CEMVP-RPEDN-PD-F, 3 October 2019

STEAMBOAT ISLAND HREP

PDT MEETING ATTACHMENTS

07 Nov 2019

US Army Corps of Engineers

U.S. ARMY

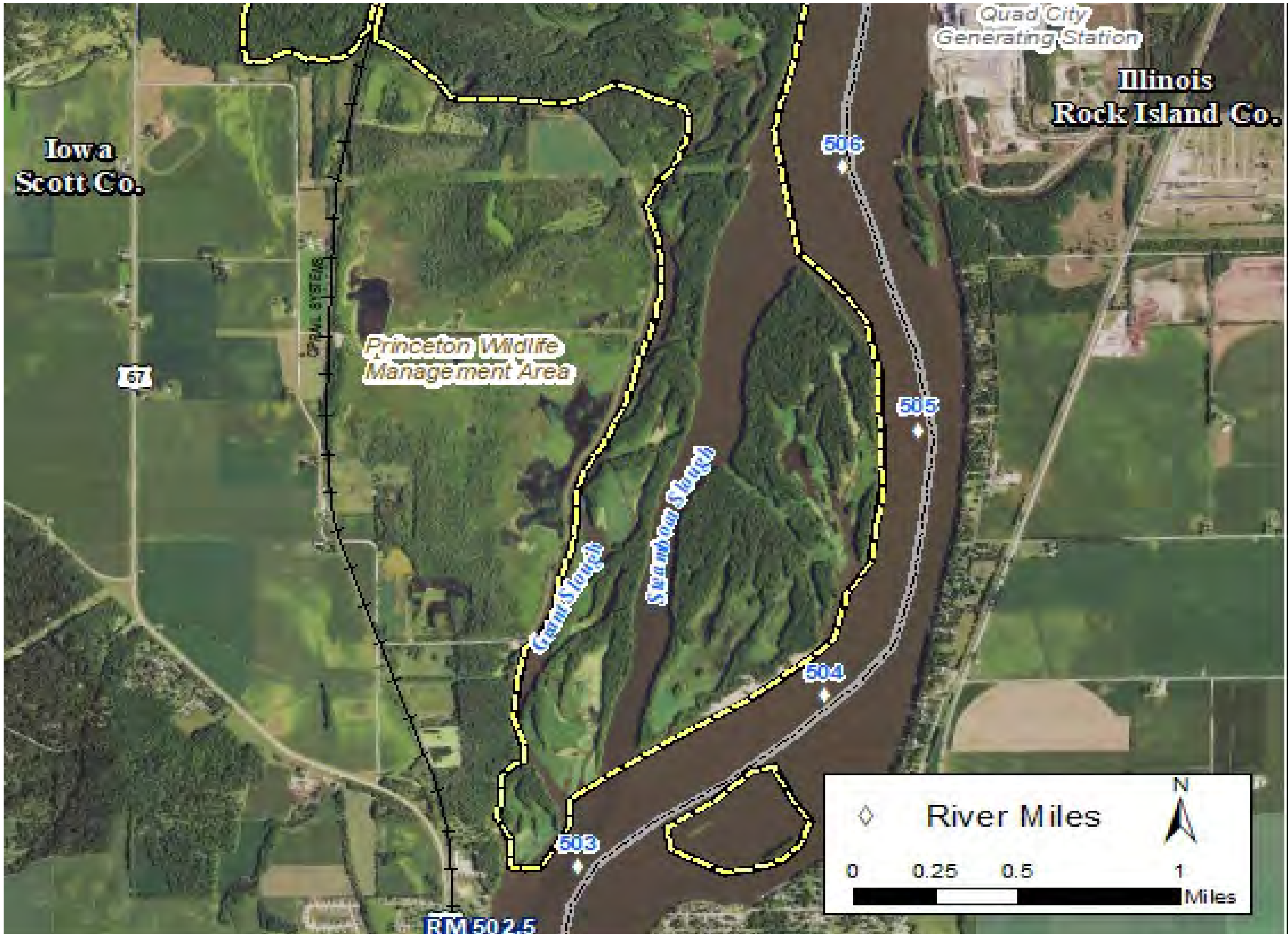
2019 DRAFT MUSSEL SURVEY RESULTS

Davi Michl, PD-P

07 Nov 2019

CAVEAT: ALL INFORMATION CONTAINED IN THIS PACKAGE IS BASED OFF RAW DATA ONLY – CONTRACTOR REPORT IS NOT YET AVAILABLE

PROJECT LOCATION



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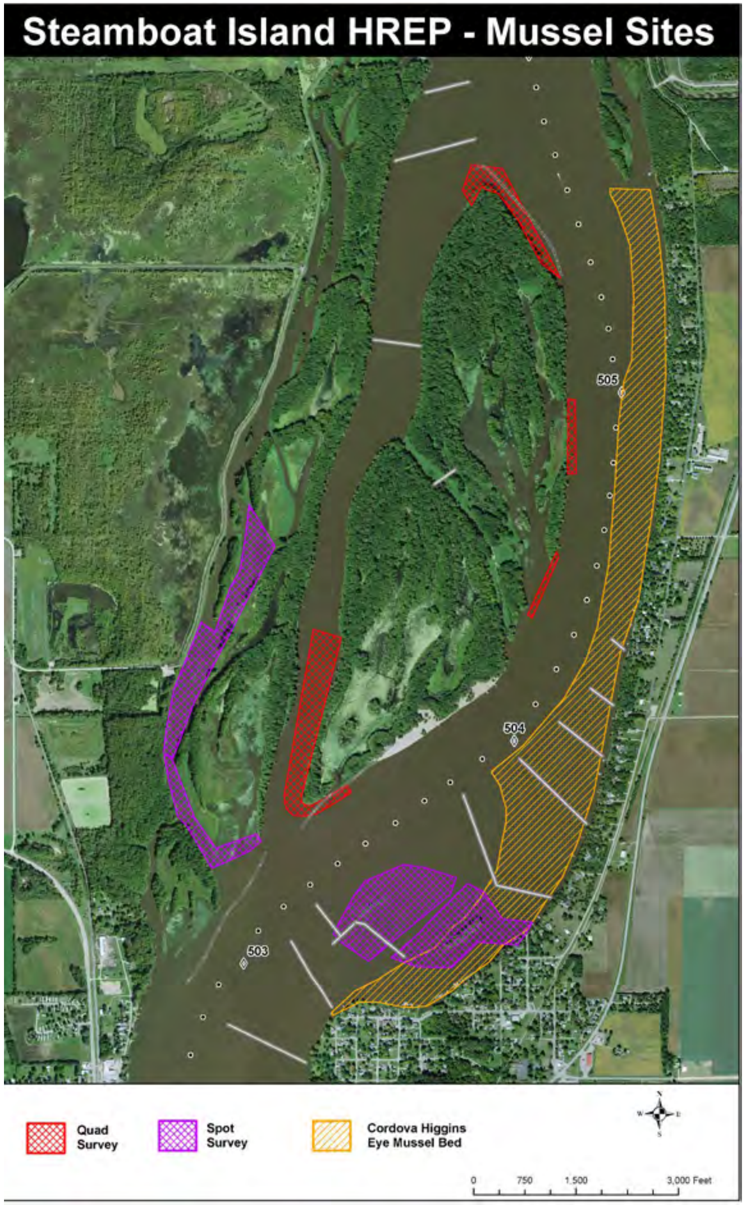
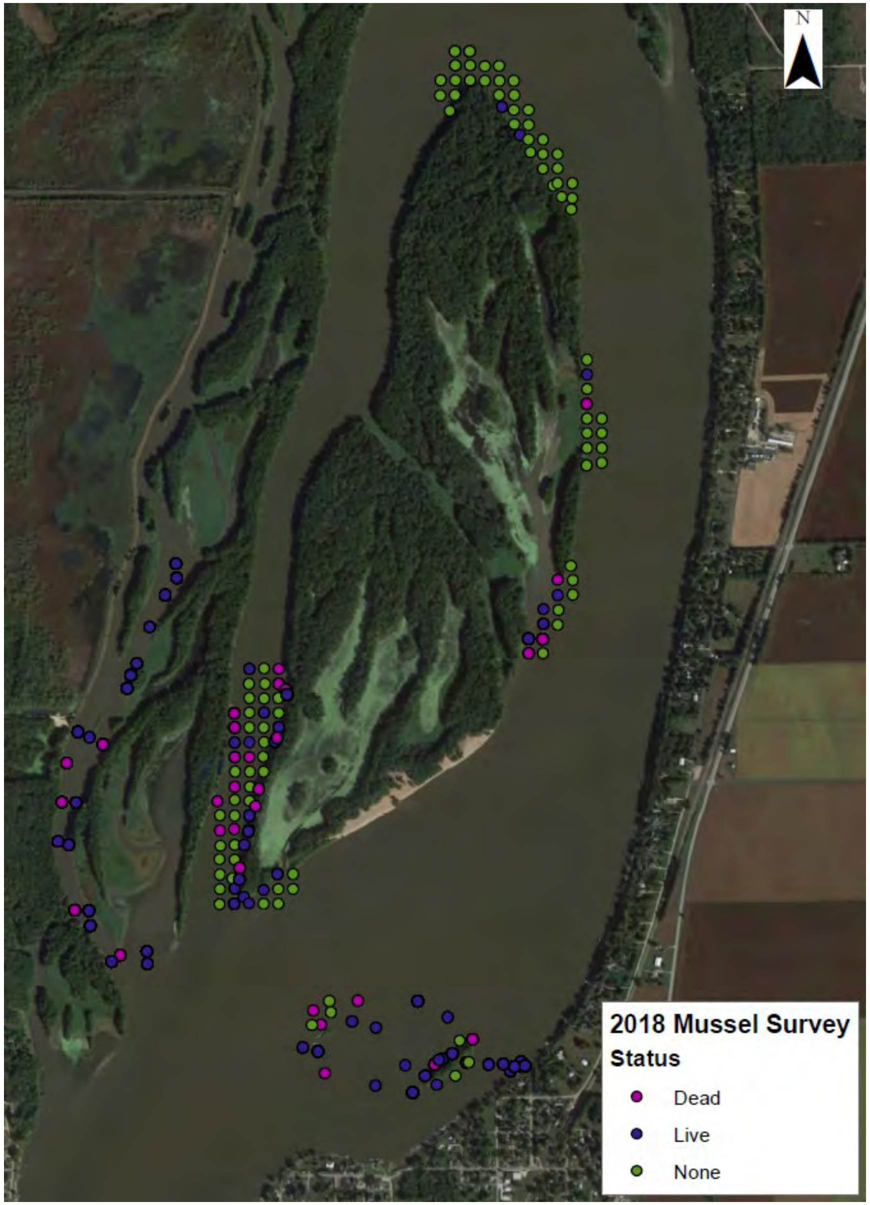
2018 MUSSEL SURVEY

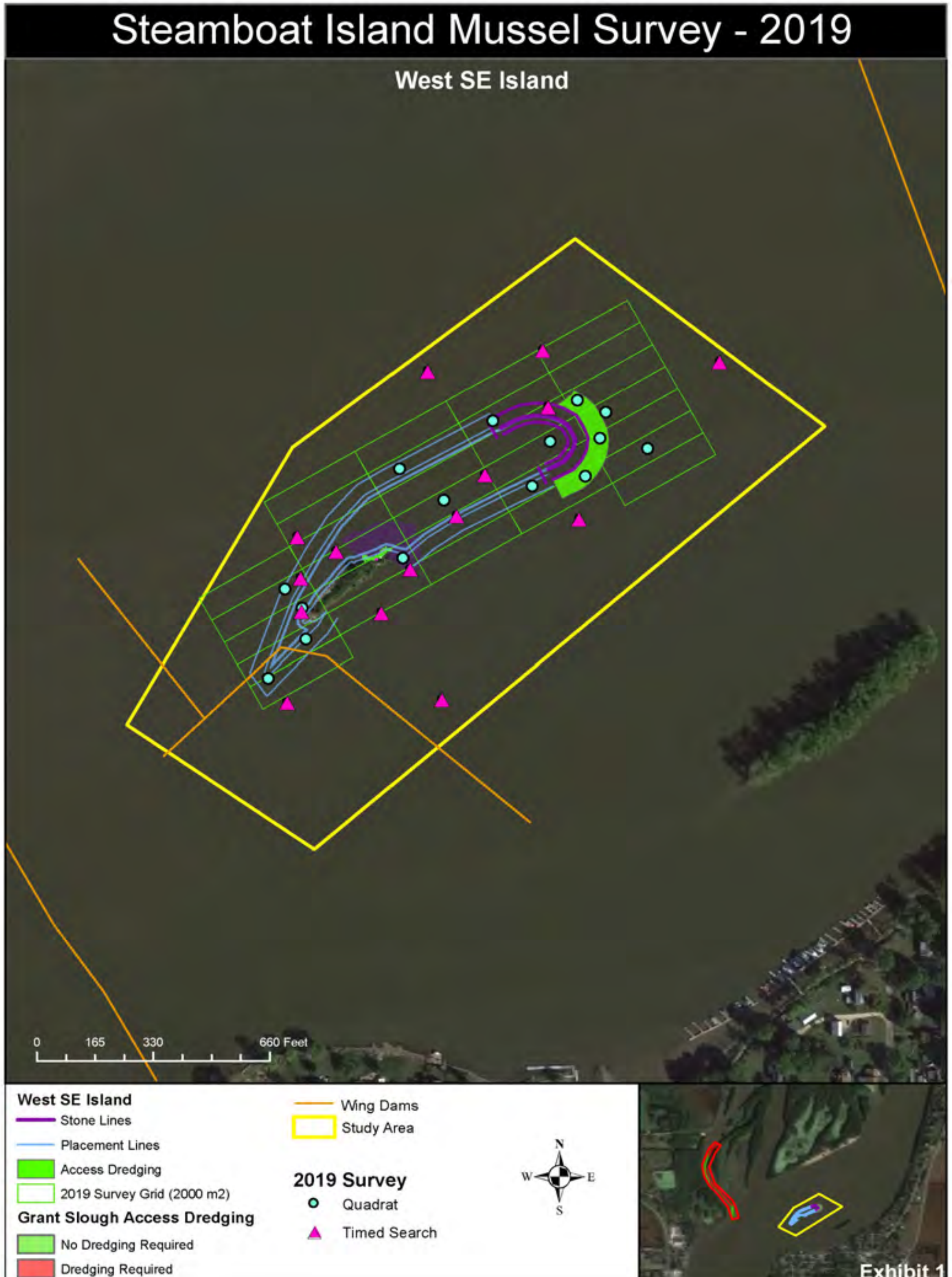




SAMPLE LOCATIONS & METHOD

- 18-19 Aug. 2019
- Total 50 sampling locations
  - 25 Quadrats
  - 25 Timed Searches
- Grant Slough
  - Goal: Survey Proposed Dredging Areas for Presence/Absence
    - 10 Quads
    - 10 **5-min** Timed

SAMPLE LOCATIONS & METHOD



- West SE Island
  - 15 Quads
  - 15 **10-min** Timed
    - Consistent with 2013 survey guidelines (2,000 m^2 grid with random start)
- Goals:
  - Increase coverage & fill in spatial gaps
  - Verify consistent substrate conditions

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DESCRIPTIVE STATS

- Total 270 live mussels, 20 species
- Quadrats
  - 52 live mussels, 10 species
    - 0 live mussels @ 100 % West SE Island sites
    - Live mussels @ 80% Grant Slough sites (max 18)
  - Mussels concentrated @ upstream edge
- Timed Searches
  - 218 live mussels, 19 species
    - Live mussels @ 53% West SE Island timed intervals (max 3)
    - Live mussels @ 100% Grant Slough timed intervals (max 32)
- Age structure (mean = 19 yrs; min=1/max=55))
  - ≤ 5 yrs = 5.2% (14/270)
  - ≥ 15 yrs = 71.9% (194/270)

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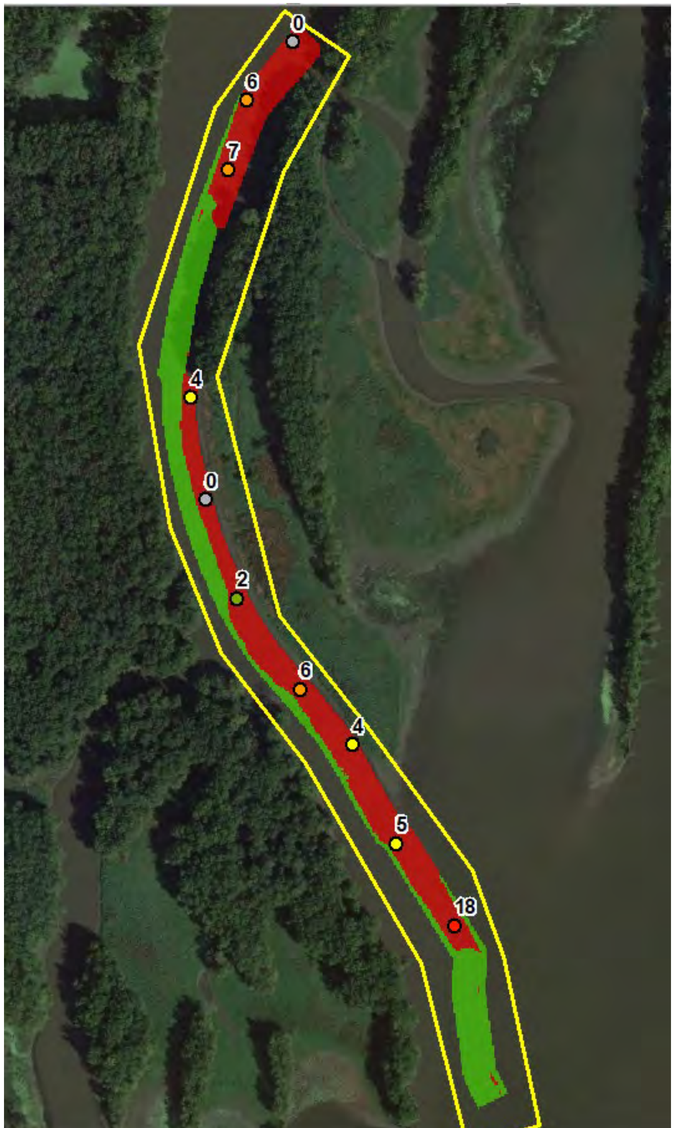
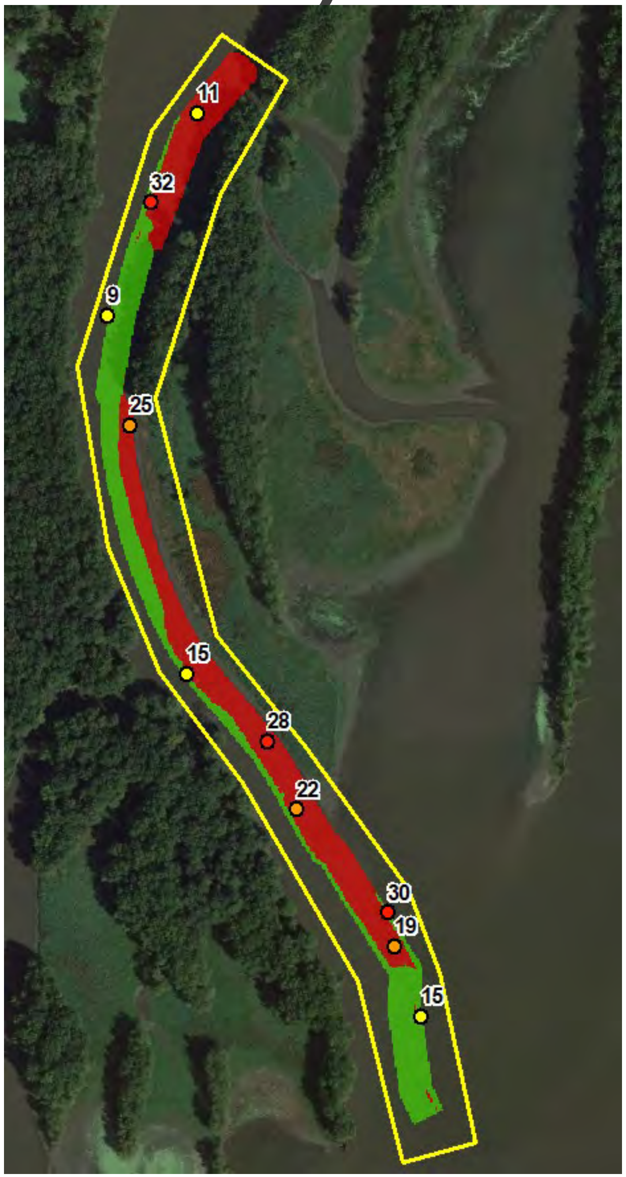
QUADRAT ABUNDANCE (NO/0.25 M^2)



QUALITATIVE ABUNDANCE (NO./TIMED SEARCH)



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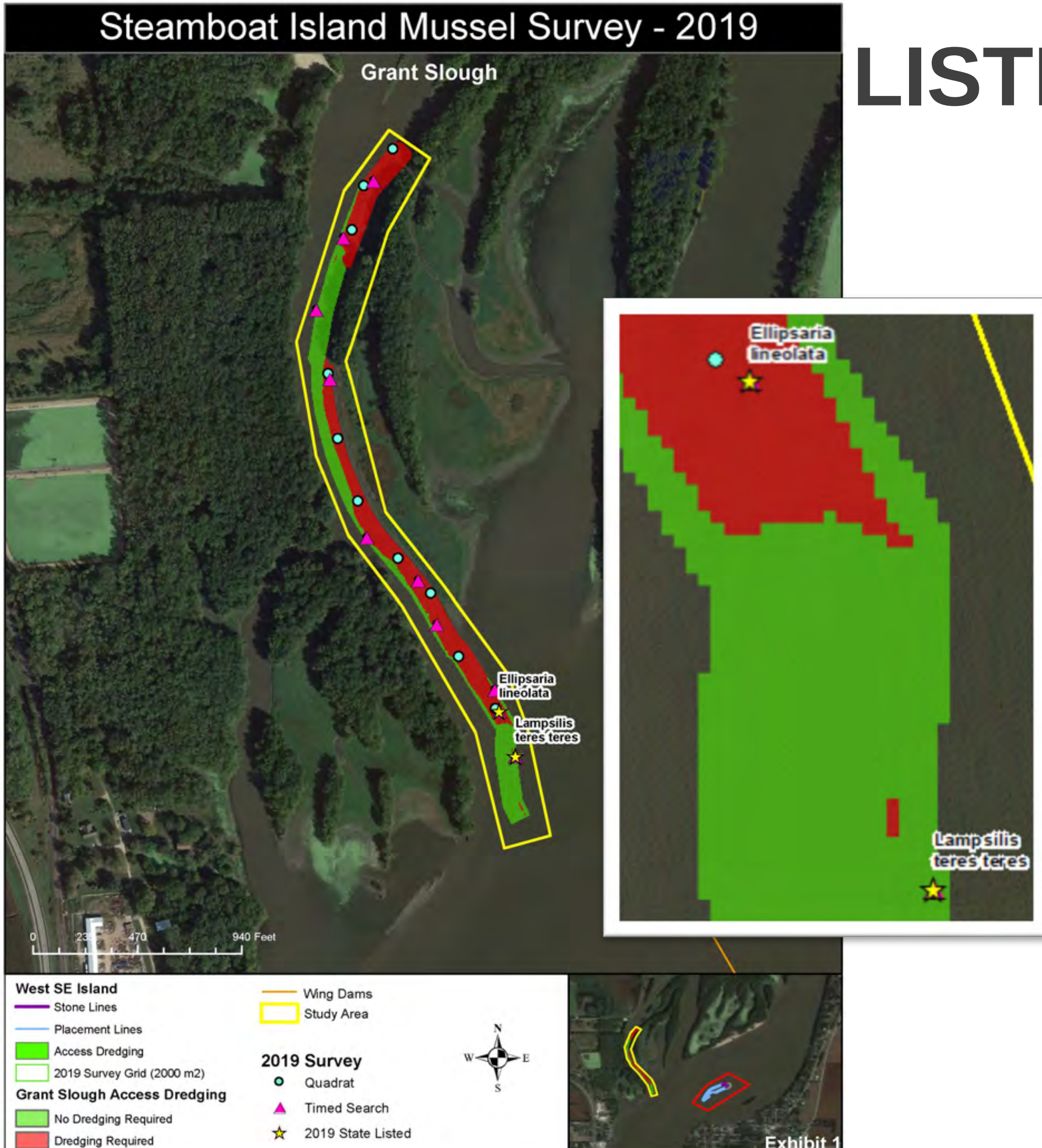
LISTED SPECIES



- NO Federally-listed
- Grant Slough
- State-listed
  - IA-E
    - *Lampsilis teres* (yellow sandshell, 1)
  - IL-T/IA-T
    - *Ellipsaria lineolata* (butterfly, 1)

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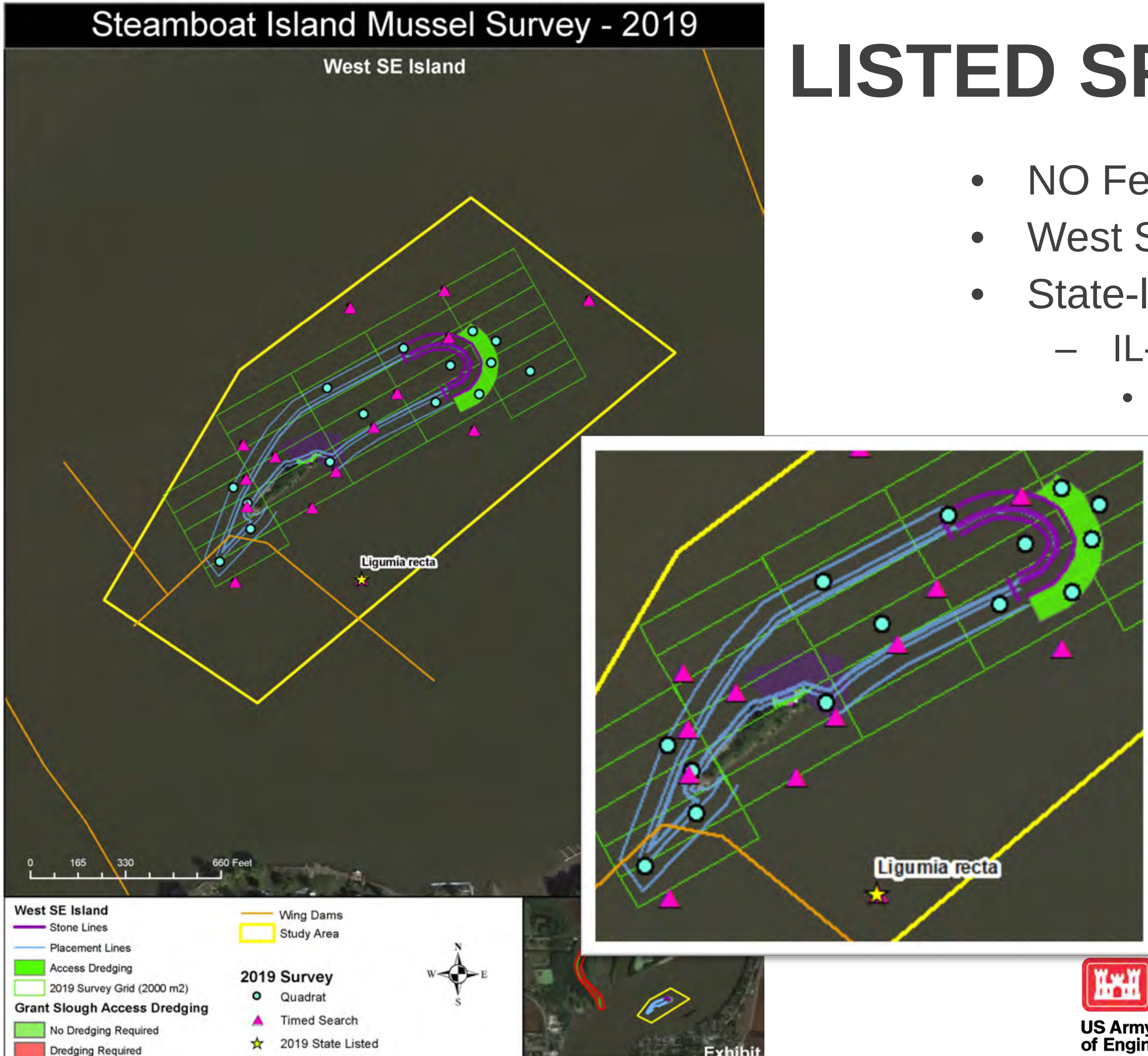
LISTED SPECIES

- NO Federally-listed
- West SE Island
- State-listed
  - IL-T
    - Ligumia recta (black sandshell,1)



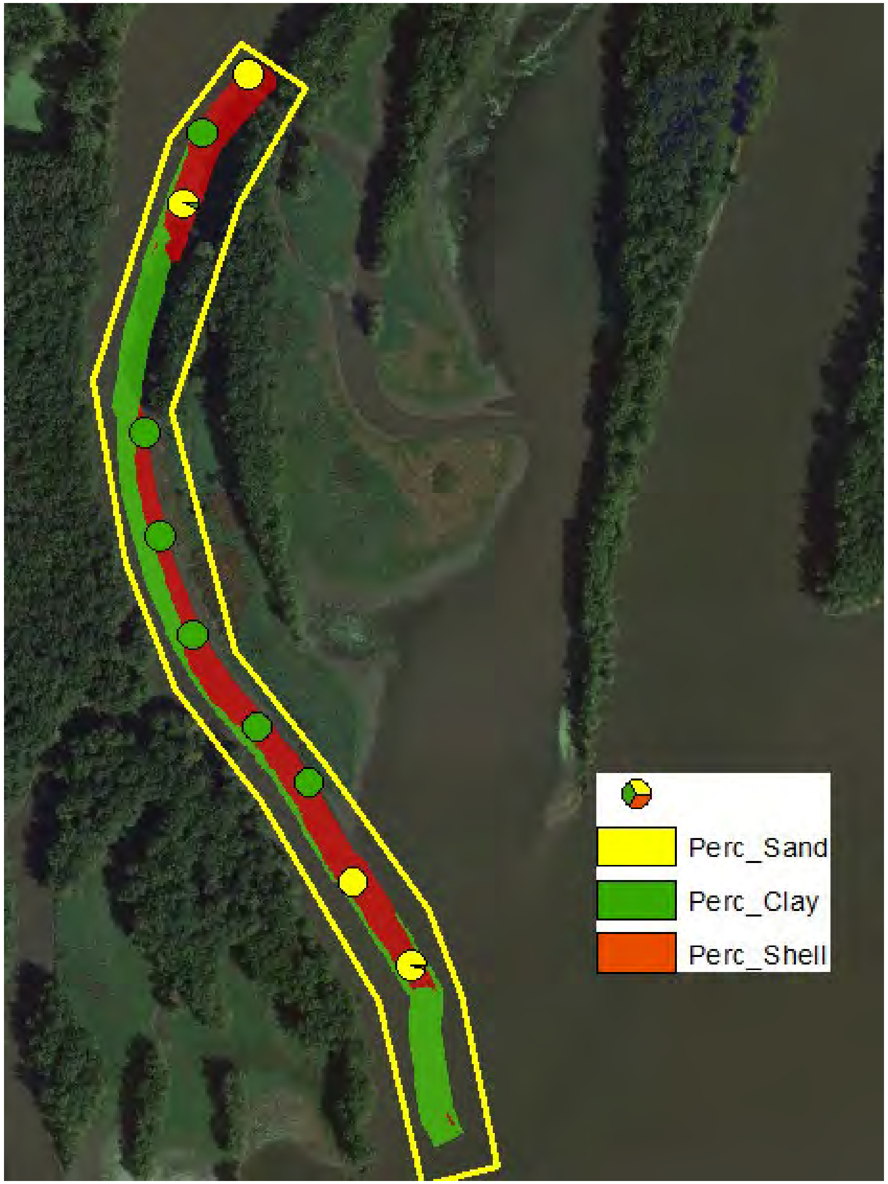
SPECIES COUNTS

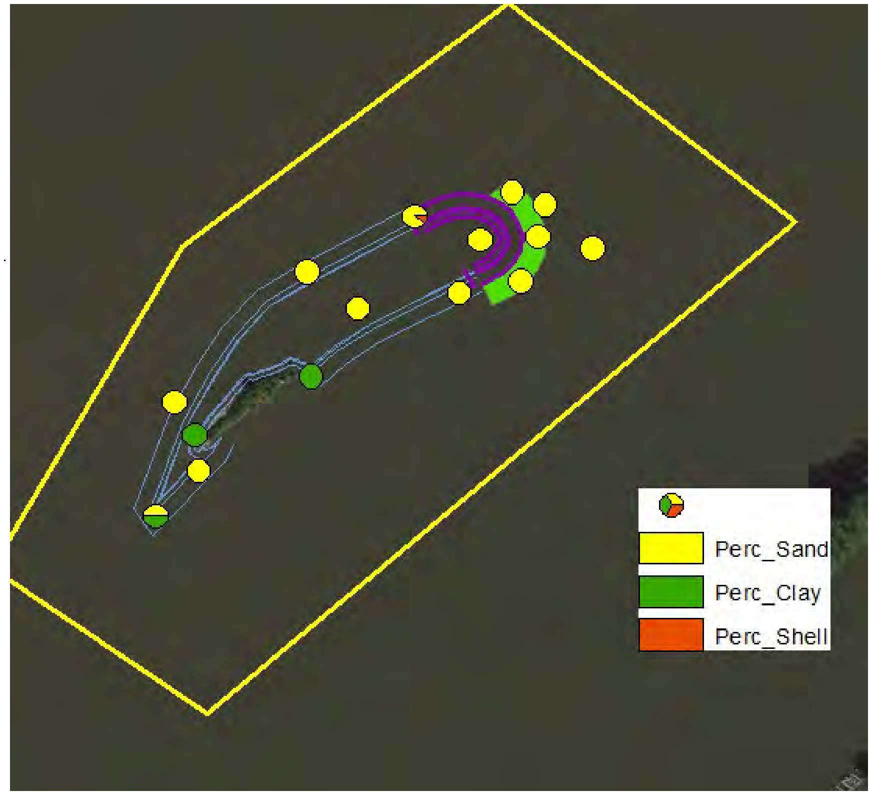
- *Amblema plicata* (threeridge) – 35.6% (n = 96)
- *Quadrula quadrula* (mapleleaf) – 15.2% (n = 41)
- *Obliquaria reflexa* (threehorn wartyback) – 12.6% (n = 34)
- *Quadrula pustulosa pustulosa* (pimpleback) – 10% (n = 27)
- *Truncilla donaciformis* (fawnsfoot) – 6.7% (n = 18)
- *Potamilus alatus* (pink heelsplitter) – 6.7% (n = 18)

- ≤ 7 individuals/14 remaining species

QUADRAT SUBSTRATE

- Grant Slough
  - 100% clay @ 60% sites
- West SE Island
  - 100% sand @ 73.3% sites; confirmed conditions from 2018





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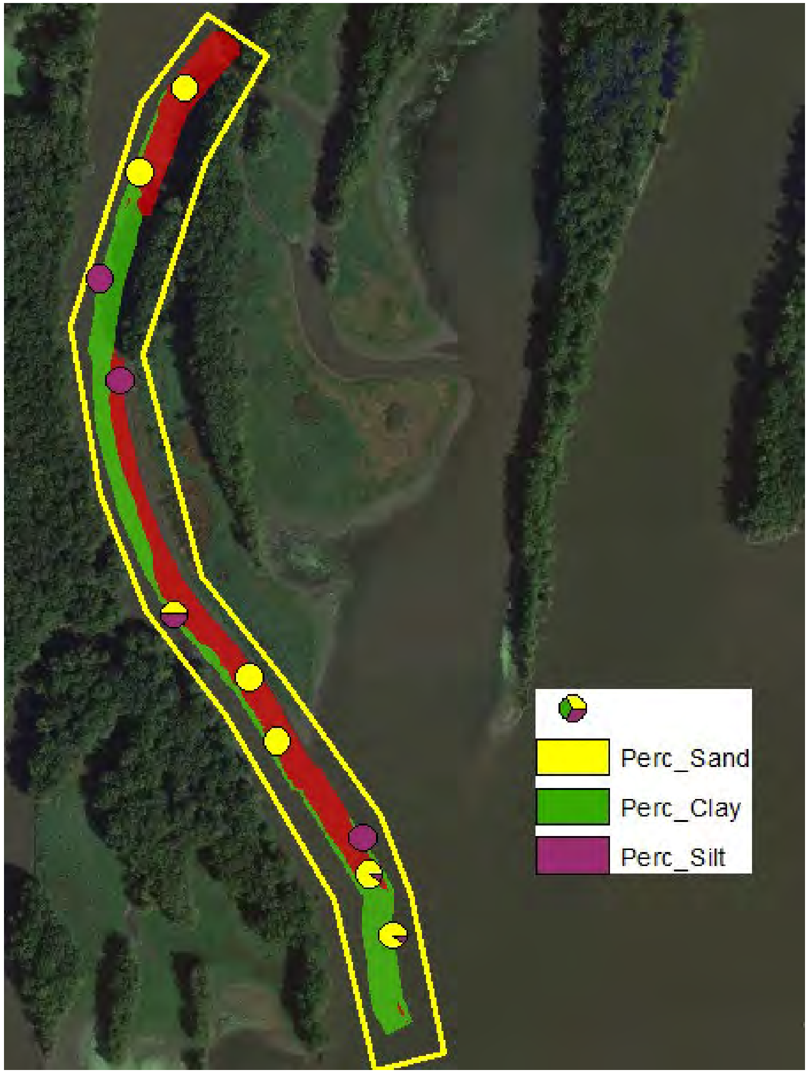
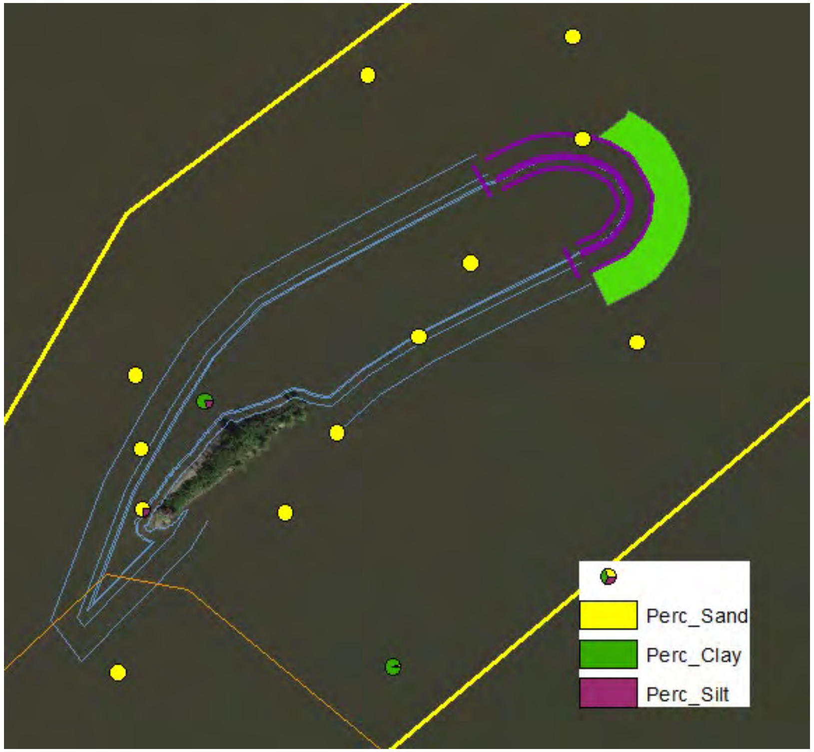
TIMED SEARCH SUBSTRATE

- Grant Slough
  - 100% sand @ 40% sites
- West SE Island
  - 100% sand @ 73.3% sites





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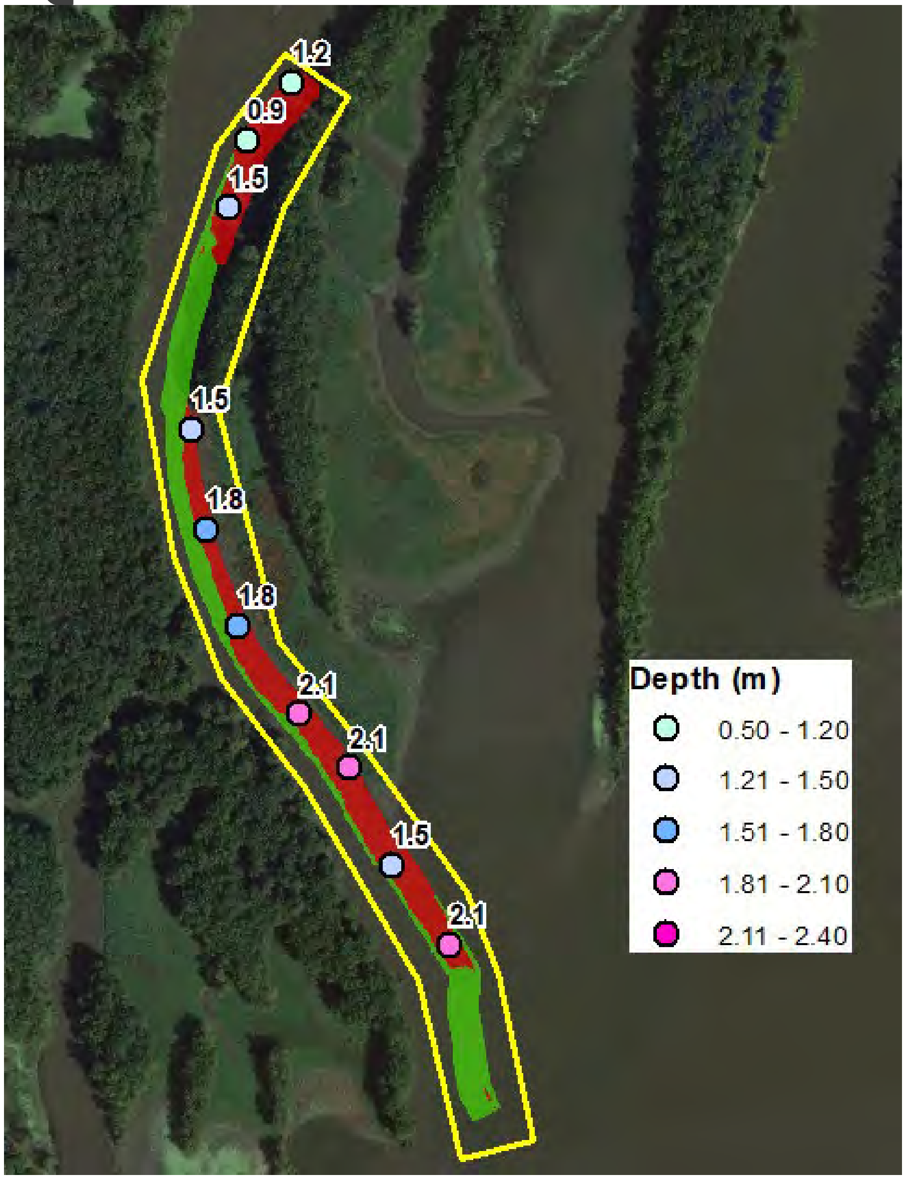
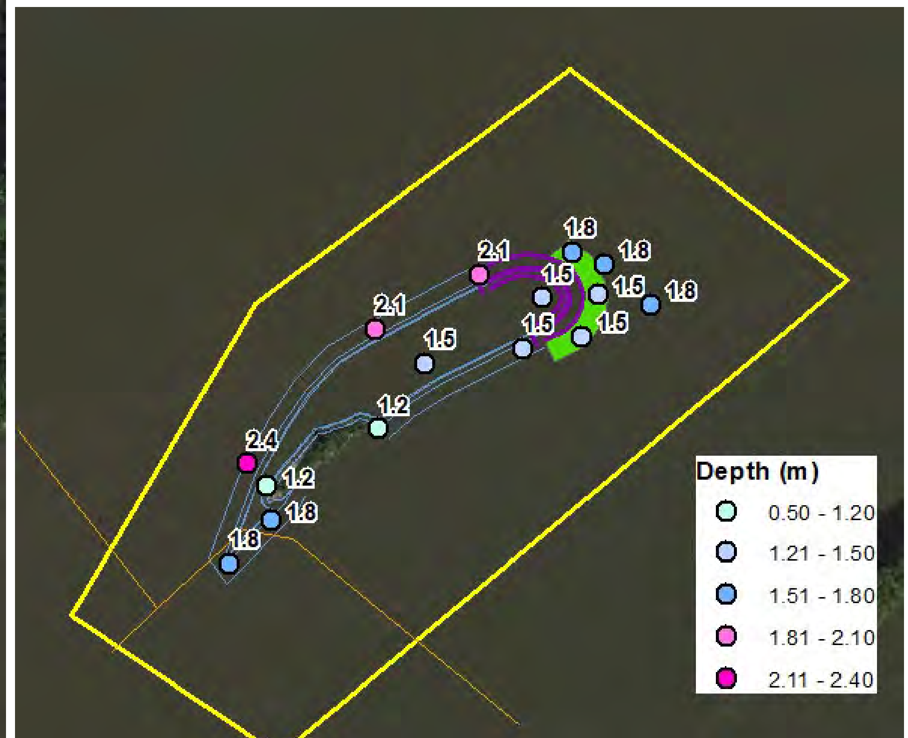
QUADRAT DEPTHS (M)





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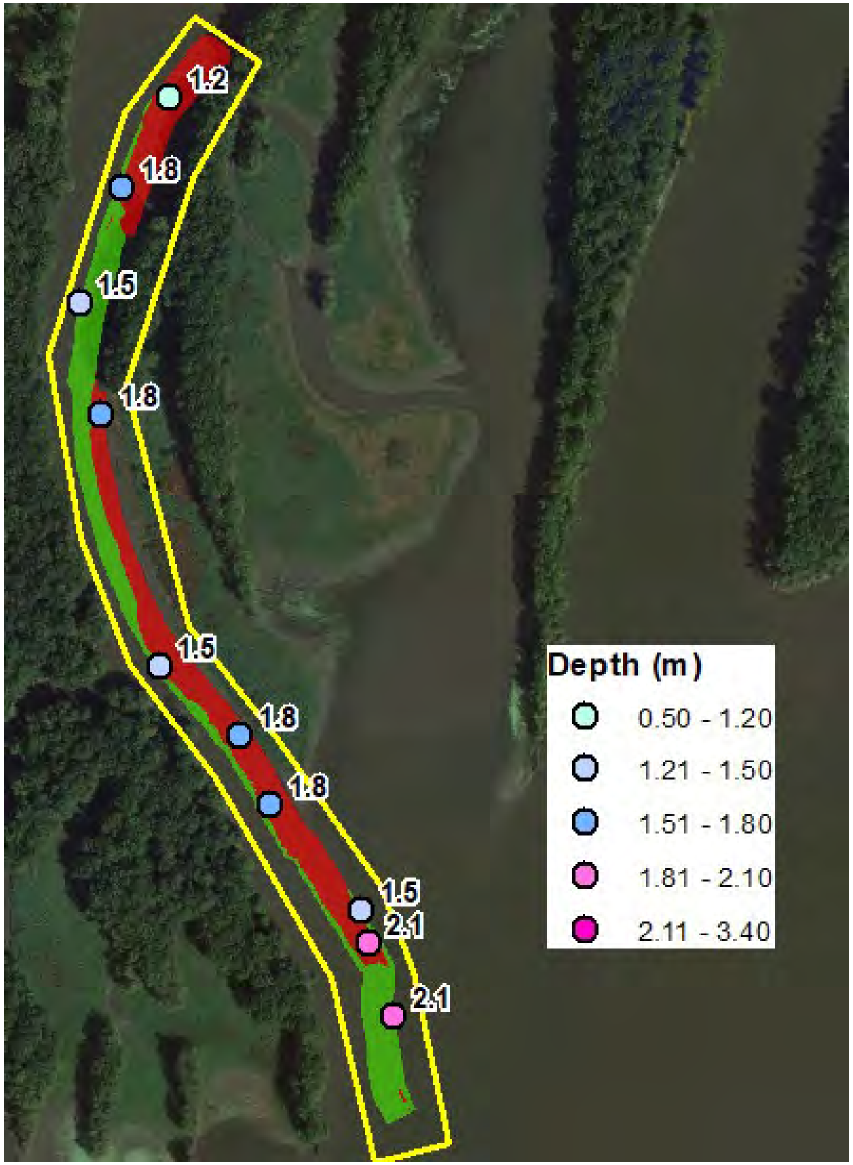
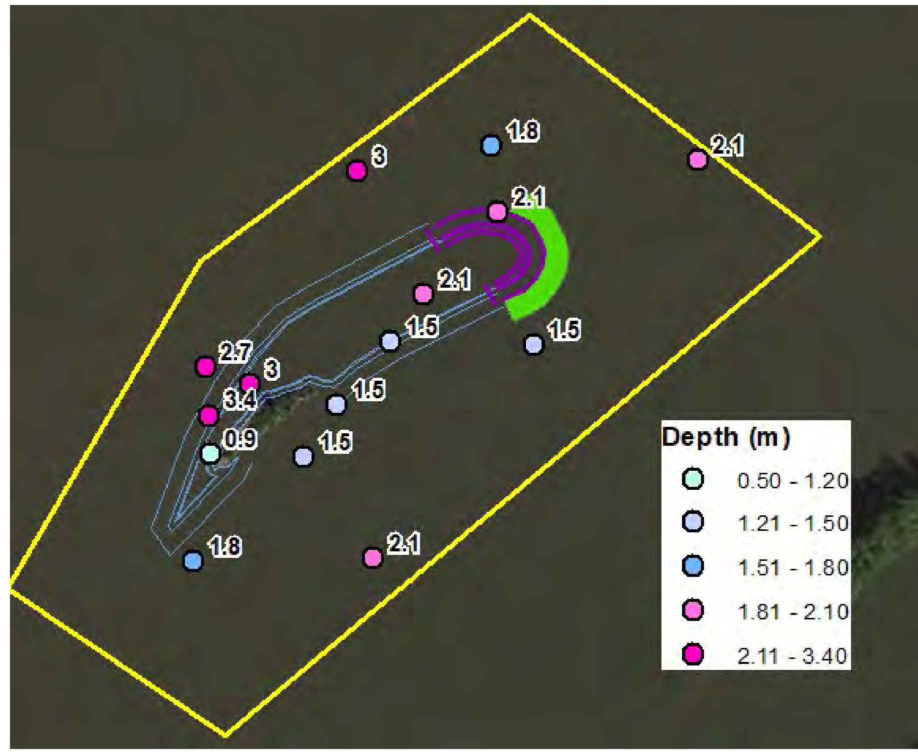
TIMED SEARCH DEPTHS (M)





US Army Corps of Engineers

U.S. ARMY

From: MICHL, DAVI E [redacted]
To: MICHL, DAVI E [redacted]
Cc: Perrine, Rachel E [redacted]
Subject: Steamboat - 19 Dec 2019 call FWS (UNCLASSIFIED)
Date: Thursday, December 19, 2019 7:55:00 AM

CLASSIFICATION: UNCLASSIFIED

FYI

Telephone call 19 Dec 2019 with Sara Schmuecker, per District Responses to FWS FS Review:

NLAA or No Effect determination =no BA no BO; informal consultation concluded by letter

MR, p. II-15: avoidance during active season = bat surveys not required
3 in 5 inch foraging habitat for bats Indiana vs NLEB (not 15 inches)

Sara added some clarifying language to the document - Environmental concurs

V/R,

Davi Michl
Regional Planning and Environment Division North
U.S. Army Corps of Engineers
[redacted]

[redacted]

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
PO BOX 2004 CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS 61204-2004

December 20, 2019

Regional Planning and Environmental
Division North (RPEDN)

SUBJECT: Steamboat Island Habitat Rehabilitation and Enhancement Project, Clinton and Scott Counties, Iowa, and Rock Island County, Illinois

Review and Compliance Coordinator
State Historic Preservation Office
600 East Locust
Des Moines, Iowa 50319-0290

This letter is to inform you of an upcoming U.S. Army Corps of Engineers, Rock Island District (District) habitat rehabilitation and enhancement project (Project) on Steamboat Island in Rock Island County, Illinois, and Clinton and Scott Counties, Iowa. Steamboat Island is located between river miles 502.5 and 508.0 on the Mississippi River (Enclosure 1). The Project details are briefly outlined below. The identification and evaluation of historic properties and determinations of effect will not be completed prior to the completion of the environmental assessment needed for compliance with the National Environmental Policy Act (NEPA), making the execution of a Programmatic Agreement (PA) for this Project an appropriate course of action, pursuant to 36 CFR 800.14(b)(1)(ii). The District greatly values your participation and input, inviting your agency to participate as a consulting party and signatory in a forthcoming PA as per 36 CFR 800.14(b)(1)(ii).

Historic Properties

Portions of the Project area have been subjected to cultural survey and have resulted in the documentation of three archeological sites (Enclosure 2). Archeologist Charles R. Keyes noted a possible historic Sauk or Meskwaki village at the mouth of the Wapsipinicon River. Designated site 13CN36, this village appears in the ISF GIS database as an upward-facing triangle, meaning both the site's location and boundaries are uncertain. Site 13CN59 is a historic Euro-American scatter recorded in the Iowa Site File GIS database as a downward-facing triangle, meaning the site's location is known, but its boundaries are uncertain. These two sites are discussed in a 1989 Benn et al. report; this report recommended site 13CN59 be preserved. The site 13CN36 recommendation called for subsurface testing to pinpoint the definite site location.

The final previously recorded site, isolated prehistoric find 13CN78, is documented in Stanley's 1996 report, where he mentions finding two pieces of flaking debris, one each found in the upper 10 cm of two shovel tests. Stanley recommended the site ineligible for National Register of Historic Places (NRHP) listing. The Iowa State Historic Preservation Office (SHPO) Database of Section 106 Review and Compliance Decisions for specific sites (accessible through the ISF GIS database) notes that, on 17 May 1996, the SHPO determined the site ineligible for NRHP listing.

Additionally, a review of the 1930s Corps land acquisition/topographic maps reveals a variety of buildings and structures once stood within the Project area. These include fences, a log race related to timber harvests, a bridge, a pump, a small "stone dam," the side channel closing dam (labeled "stone retarding dam"), and several small buildings which likely functioned as hunting or fishing cabins. These structures are currently unevaluated.

Federal Undertaking

Pursuant to the National Historic Preservation Act (NHPA) of 1966, as amended, and its implementing regulations, 36 CFR Part 800, the District has determined that work at Steamboat Island has potential to cause effects to a historic property [36 CFR 800.3(a)(1)] and as a consequence will require a determination of effect within the Area of Potential Effect (APE).

Area of Potential Effect

The Project is located in T80N, R5E, Sections 11, 12, 13, 14, in Clinton County, Iowa, T80N, R5E, Sections 23, 24, 25, 35, 36, in Scott County, Iowa, T79N, R5E, Sections 1 and 2, Scott County, Iowa, and in T20N, R1E, Sections 25, 30, 36 in Rock Island County, Illinois. All Project lands are in Federal ownership by the District and the U.S. Fish and Wildlife Service (USFWS), and are managed via cooperative agreement between both parties as part of the Upper Mississippi River National Wildlife and Fish Refuge (NWFR). The Project and area of potential effect (APE) encompasses 2,627 acres of interconnected backwaters, secondary channels, wetlands, and islands. Approximately 1,820 acres of the Project area is terrestrial, with the remaining acreage permanently or seasonally inundated. The APE boundaries may be refined as the project progresses. The majority of the APE resides in Iowa, including Steamboat Island and land immediately adjacent to the west of the slough. The Illinois APE includes only a small island to the southeast of Steamboat Island.

Present and Proposed Courses of Action

The Project goals are to maintain, enhance, and restore quality habitat for desirable native plant, animal, and fish species and maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem. This will be accomplished through a variety of actions including (Enclosure 3):

- excavate channels and restore overwintering habitat in backwater areas
- construct topographic diversity, to include forest, scrub/shrub, and pollinator habitat restoration and enhancement
- implement Timber Stand Improvement (TSI) techniques
- restore and protect islands
- construct bank protection and incorporate mussel substrate, where appropriate

Specific project features, including design and execution of the timber stand improvements, are not currently known. However, the types of actions to be performed and their potential impacts will be included in the PA.

Although contractors have been secured to perform the necessary work, the geomorphological and cultural evaluations of the Area of Potential Effect (APE) have been delayed due to excessive and prolonged high water and flooding of the project area. In order to effectively evaluate the APE for cultural resources, the pool level needs to at or below 10.1 feet. For the past five years, the majority of the work areas have been inundated (Enclosure 4). Therefore, a full assessment of effects to cultural resources for the project activities cannot be determined at this time. It is due to this constant inundation that the cultural and geomorphological surveys have been delayed. Once the pool level reaches the necessary level, work described in the stipulations of the forthcoming PA will be completed and cultural and geomorphological assessments will be conducted. Determinations of effect will then be made. The geomorphological assessments of the entire APE will aid in directing cultural work.

This PA will be included in an appendix of the final National Environmental Policy Act (NEPA) document, the Environmental Assessment (EA) as per 36 CFR 800.8. The draft EA will be available for public review. Evidence of this PA will be included in the draft EA. The PA is necessary as the District needs to complete the NEPA process, but cultural work has not been completed due to lack of access.

The District would like all future courses of action, including development of the PA, to involve the Iowa SHPO and other consulting party's input, thus ensuring that future decisions regarding the site are in line with consulting party wishes.

Consulting Parties Invitation

The Corps identified you as a consulting party for this undertaking (36 CFR 800.2) and invites your participation in the Section 106 process. Ultimately, the goal of the consultation is to identify any concerns and reach mutually agreeable decisions while taking into account the interests of Tribal, state and Federal governments and other consulting parties. The Distribution List (Enclosure 5) reflects the parties that received this mailing. The District invites you to identify any other consulting parties and provide input on issues relating to this undertaking.

The District hopes your agency will agree to participate as a consulting party and choose to participate as a signatory of the PA. If you wish to participate, please provide the District with a letter, email, or phone call to that effect within 30 days of receipt of this letter. Please also provide the District with a point of contact for future consultation on the Project.

The District's point of contact for this action is Ms. Christine Nycz of our Environmental Compliance Branch at ([redacted] by e-mail: [redacted] or in writing to our address, ATTN: Environmental Compliance Branch (Christine Nycz).

Sincerely,

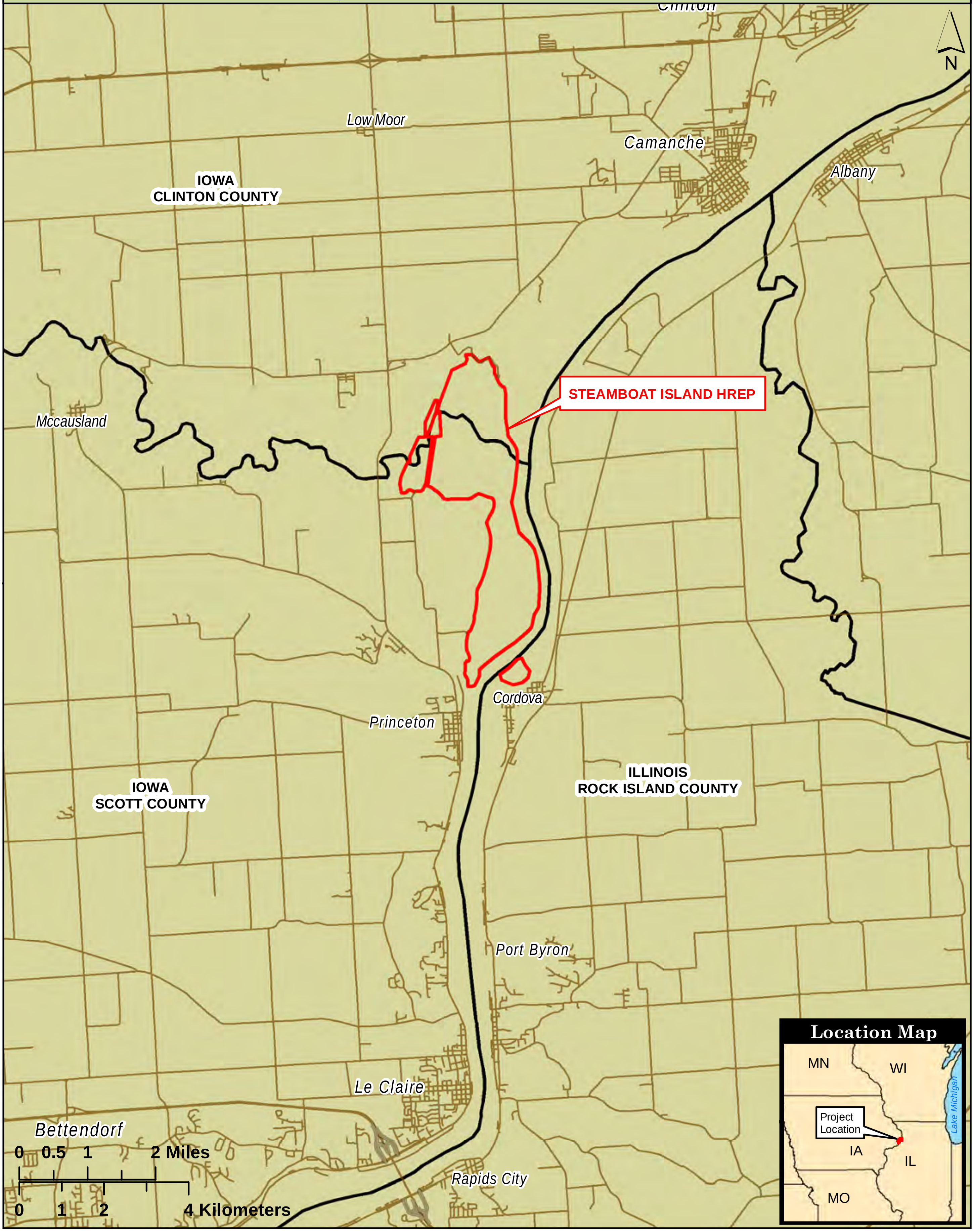
Jodi K Creswell

Jodi Creswell
Chief, Environmental Planning
Branch (RPEDN)

Enclosures (5)

US Army Corps of Engineers®
Rock Island

Steamboat Island HREP Project Location Map, Clinton & Scott Counties, Iowa, and Rock Island County, Illinois: Enclosure 1

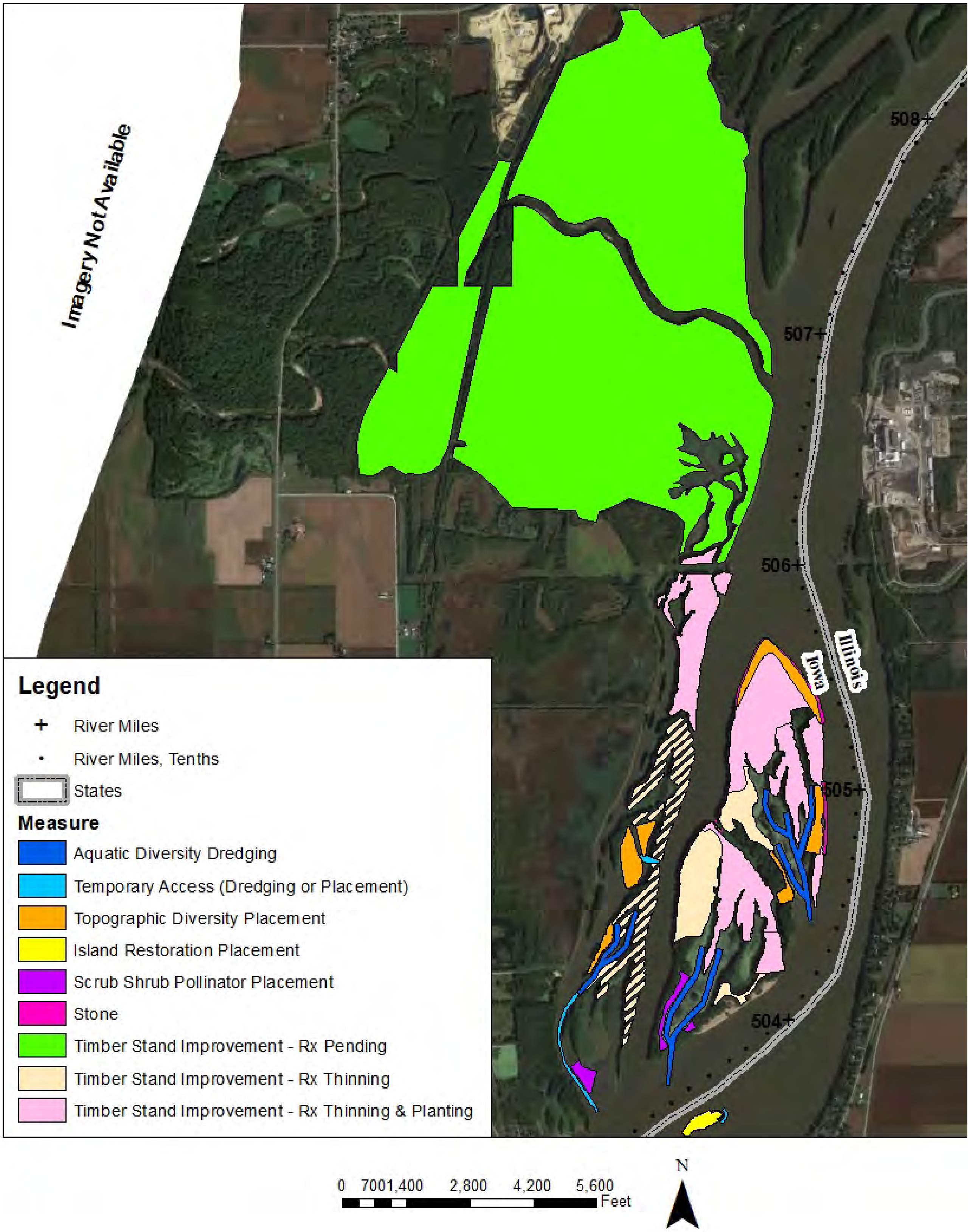


ENCLOSURE 2

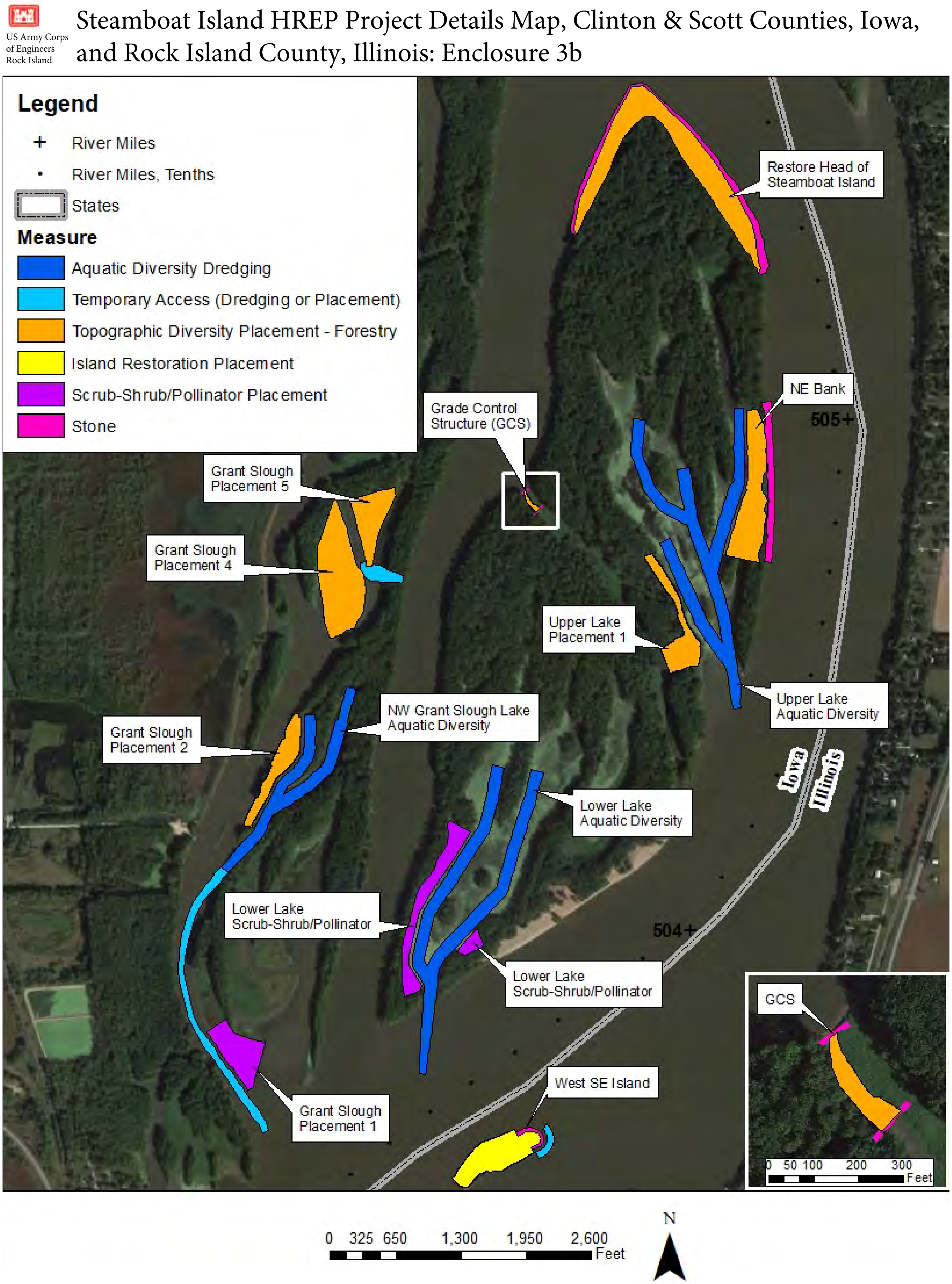
This enclosure has been removed. The Archaeological Resources Protection Act of 1979 prohibits the distribution of site location information to the public.

US Army Corps of Engineers Rock Island

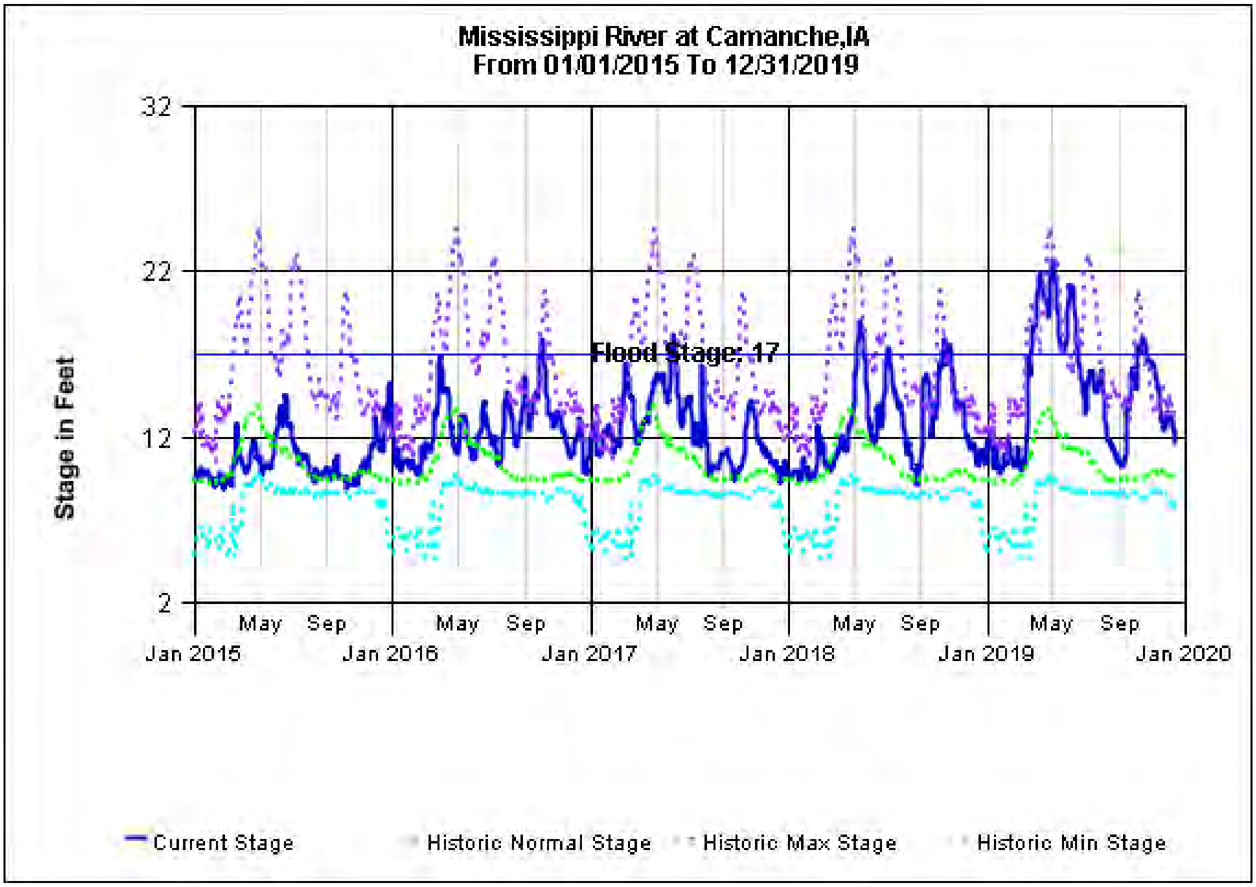
Steamboat Island HREP Project Details Map, Clinton & Scott Counties, Iowa, and Rock Island County, Illinois: Enclosure 3



Steamboat Island HREP Project Details Map, Clinton & Scott Counties, Iowa, and Rock Island County, Illinois: Enclosure 3b



Enclosure 4: Flood Stage Graph



Graph showing five year water levels at the Camanche, IA river gage, located five miles north of the Wapsipinicon River confluence with the Mississippi River (near the north end of the Steamboat Island HREP project area).

Enclosure 5: Distribution List

MR. STEVE VANCE, THPO
CHEYENNE RIVER SIOUX TRIBE
PO BOX 590
EAGLE BUTTE , SD 57625

DR. KELLI MOSTELLER, THPO
CITIZEN POTAWATOMI NATION
1601 S GORDON COOPER DR
SHAWNEE, OK 74801

MERLE MARKS, THPO
CROW CREEK SIOUX TRIBE OF THE CROW CREEK RESERVATION, SD
PO BOX 50
FT. THOMPSON, SD 57339

MR. GARRIE KILLSAHUNDRED, THPO
FLANDREAU SANTEE SIOUX TRIBE
22964 483RD AVE.
FLANDREAU, SD 57028

MR. MICHAEL LARONGE, THPO
FOREST COUNTY POTAWATOMI COMMUNITY
PO BOX 340
CRANDON, WI 54520

MR. DYAN YOUPEE, THPO
FORT PECK ASSINIBOINE & SIOUX TRIBES
P.O. BOX 1027
POPLAR, MT 59255

JAN HANSEN CITY OF CLINTON
HISTORIC PRESERVATION COMMISSION
611 S. 3RD ST. PO BOX 2958
CLINTON, IA 52732

MR. BILL QUACKENBUSH, THPO
HO-CHUNK NATION
PO BOX 667
BLACK RIVER FALLS, WI 54615

MR. JEFF KRUCHTEN, SHPO
ILLINOIS STATE HISTORIC PRESERVATION OFFICE
1 OLD STATE CAPITOL PLAZA
SPRINGFIELD, IL 62701

MS. HEATHER GIBB, R&C COORDINATOR
IOWA STATE HISTORIC PRESERVATION OFFICE
600 EAST LOCUST
DES MOINES, IA 50319

COMPLIANCE AND REVIEW
IOWA STATE HISTORIC PRESERVATION OFFICE
600 EAST LOCUST
DES MOINES, IA 50319-0290

MR. LANCE FOSTER, THPO
IOWA TRIBE OF KANSAS & NEBRASKA
3345 B THRASHER RD
WHITE CLOUD, KS 66097

MR. EAGLE MCCLELLAN, CULTURAL PRESERVATION DIRECTOR
IOWA TRIBE OF OKLAHOMA
335588 E 750 RD
PERKINS, OK 74059

MS. CRYSTAL DOUGLAS, THPO
KAW NATION
DRAWER 50
KAW CITY, OK 74641

Enclosure 5: Distribution List

MR. CURTIS SIMON, NAGPRA REPRESENTATIVE
KICKAPOO TRIBE IN KANSAS
1107 GOLDFIND RD
HORTON, KS 66439

MR. KENT COLLIER, NAGPRA REPRESENTATIVE
KICKAPOO TRIBE IN OKLAHOMA
PO BOX 70
MCLOUD, OK 74851

MS. CHEYANNE ST. JOHN, THPO
LOWER SIOUX INDIAN COMMUNITY
PO BOX 308
MORTON, MN 56270

MR. DAVID GRIGNON, THPO
MENOMINEE INDIAN TRIBE OF WISCONSIN
PO BOX 910
KESHENA, WI 54135-0910

MS. DIANE HUNTER, THPO
MIAMI TRIBE OF OKLAHOMA
PO BOX 1326
MIAMI, OK 74355

MR. THOMAS BRINGS, THPO
OGLALA SIOUX TRIBE
PO BOX 320
PINE RIDGE, SD 57770

MR. THOMAS PARKER, THPO
OMAHA TRIBE OF NEBRASKA
PO BOX 368
MACY, NE 68039

MR. JESS HENDRIX, ARCHEOLOGIST
OSAGE NATION
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PAWHUSKA, OK 74056

MS. ELSIE WHITEHORN, THPO
OTOE-MISSIOURIA TRIBE
8151 HWY 177
RED ROCK, OK 74651

MR. LOGAN PAPPENFORT, NAGPRA REPRESENTATIVE
PEORIA TRIBE OF INDIANS OF OKLAHOMA
PO BOX 1527
MIAMI, OK 74355

MR. NICHOLAS MAURO, THPO
PONCA TRIBE OF NEBRASKA
PO BOX 288
NIOBRARA, NE 68760

MS. HALONA CABE, THPO
PONCA TRIBE OF OKLAHOMA
20 WHITE EAGLE DR
PONCA CITY, OK 74601

MS. HATTIE MITCHELL, NAGPRA REPRESENTATIVE
PRAIRIE BAND POTAWATOMI
16281 Q ROAD
MAYETTA, KS 66509

MR. NOAH WHITEHORN, THPO
PRAIRIE ISLAND INDIAN COMMUNITY
5636 STURGEON LAKE RD
WELCH, MN 55089

Enclosure 5: Distribution List

MR. BEN RHODD, THPO
ROSEBUD SIOUX TRIBE
PO BOX 809
ROSEBUD, SD 57570

CHAIRPERSON TIAUNA CARNES
SAC & FOX NATION OF MISSOURI IN KANSAS & NEBRASKA
305 N MAIN
RESERVE, KS 66434-9723

MS. SANDRA MASSEY, NAGPRA REPRESENTATIVE
SAC & FOX NATION OF OKLAHOMA
920883 SOUTH HWY 99
STROUD, OK 74079

MR. JOHNATHAN BUFFALO, DIRECTOR HISTORIC PRESERVATION DEPT.
SAC & FOX TRIBE OF THE MISSISSIPPI IN IOWA
303 MESKWAKI RD
TAMA, IA 52339-9629

MR. DUANE WHIPPLE, THPO
SANTEE SIOUX TRIBE OF NEBRASKA
108 SPIRIT LAKE AVE W
NIOBRARA, NE 68760

MS. DIANNE DESROSIERS, THPO
SISSETON-WAHPETON OYATE
PO BOX 907
SISSETON, SD 57262

DR. ERICH LONGIE, THPO
SPIRIT LAKE NATION
PO BOX 359
FORT TOTTEN, ND 58335

MR. JON EAGLE, THPO
STANDING ROCK SIOUX TRIBE
PO BOX D
FT. YATES, ND 58538

MS. SAMANTHA ODEGARD, THPO
UPPER SIOUX COMMUNITY, MINNESOTA
PO BOX 147
GRANITE FALLS, MN 56241

MR. JAMES MYSTER, REGIONAL ARCHAEOLOGIST/RHPO
US FISH AND WILDLIFE SERVICE
5600 AMERICAN BLVD W STE 1049
BLOOMINGTON, MN 55437

MR. EBEN CRAWFORD, NAGPRA ASST.
WINNEBAGO TRIBE OF NEBRASKA
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WINNEBAGO, NE 68071

MR. KIP SPOTTED EAGLE, THPO
YANKTON SIOUX TRIBE
PO BOX 1153
WAGNER, SD 57380

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Illinois Department of **Natural Resources**

JB Pritzker, Governor
Colleen Callahan, Director

www.dnr.illinois.gov

Mailing address: State Historic Preservation Office, 1 Old State Capitol Plaza, Springfield, IL 62701

Rock Island County PLEASE REFER TO: SHPO LOG #006122319
Cordova
Between Mississippi River miles 502.5 & 508
Section:25-Township:20N-Range:1E, Section:30-Township:20N-Range:1E, Section:36-Township:20N-Range:1E
COERI
Rehabilitation & enhancement project - Steamboat Island Habitat

January 8, 2020

Jodi Creswell
Department of the Army
Corps of Engineers, Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, IL 61204-2004

Dear Ms. Creswell:

We have reviewed the documentation submitted for the referenced project(s) in accordance with 36 CFR Part 800.4. Based upon the information provided, no historic properties are affected. We, therefore, have no objection to the undertaking proceeding as planned.

Please retain this letter in your files as evidence of compliance with section 106 of the National Historic Preservation Act of 1966, as amended. This clearance remains in effect for two (2) years from date of issuance. It does not pertain to any discovery during construction, nor is it a clearance for purposes of the Illinois Human Skeletal Remains Protection Act (20 ILCS 3440).

If you are an applicant, please submit a copy of this letter to the state or federal agency from which you obtain any permit, license, grant, or other assistance. If further assistance is needed contact Jeff Kruchten, Chief Archaeologist at [redacted] or [redacted].

Sincerely,

Robert F. Appleman
Deputy State Historic
Preservation Officer

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
CLOCK TOWER BUILDING - PO BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

January 22, 2020

Regional Planning and Environmental
Division North (RPEDN)

Illinois – Iowa Services Field Office
U.S. Fish and Wildlife Service
1511 47th Avenue
Moline, IL 61265

ATTN: Kraig McPeek and Sara Schmuecker

Dear Kraig and Sara:

The U.S. Army Corps of Engineer (Corps), Rock Island District (District), is preparing to implement a habitat rehabilitation and enhancement project (Project), part of the Upper Mississippi River Restoration (UMRR) Program at Steamboat Island (Project) in Pool 14 of the Upper Mississippi River (UMR). The Project area extends along the UMR, on both sides of the navigation channel between river miles (RM) 502.5 and 508.0, Clinton and Scott Counties, IA, and Rock Island County, IL. The District obtained a list of federally endangered and threatened species with preferred habitat types for the Project area using the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) website and USFWS species fact sheets (Table 1).

A Tentatively Selected Plan (TSP) was identified and refined to avoid impacts to listed species, while also meeting the Project's goals and objectives by 1) restoring topographic diversity, including timber stand improvement (TSI) measures, to increase diversity of bottomland hardwood forest and scrub-shrub/pollinator (SSP) habitat; 2) restoring aquatic diversity in backwaters to provide year-round habitat for fish; 3) restoring and protecting island acreage from erosion, and 4) placing bankline stone protection measures to protect existing backwater habitat from sedimentation and enhance backwater interior wetlands (Enclosure 1).

With the receipt of this letter, the District is requesting concurrence with our determinations made through informal Section 7 consultation between the Corps and the USFWS on this Project. The District determined the Project is not likely to adversely affect any listed species.

Table 1. List of Federally-endangered and threatened Species with Preferred Habitat Types Which Have the Potential to Occur Within Clinton and Scott Counties, IA and Rock Island County, IL

Species	**Scientific Name**	**Status**	**Habitat Types**
Indiana bat	*Myotis sodalis*	Endangered	During the winter, caves and mines and during the summer, underneath peeling bark of dead or dying trees
Northern long-eared bat	*Myotis septentrionalis*	Threatened	During the winter, caves and mines and during the summer, underneath flaky bark, in cavities or in crevices of both live trees and snags (dead trees).
Higgins eye pearlymussel	*Lampsilis higginsii*	Endangered	Large rivers with deep water and moderate currents.
Sheepnose mussel	*Plethobasus cyphyus*	Endangered	Large rivers and streams where it is usually found in shallow areas with moderate to swift currents flowing over coarse sand and gravel.
Spectaclecase mussel	*Cumberlandia monodonta*	Endangered	Large rivers where they live in areas sheltered from the main force of the river current, such as beneath rock slabs, between boulders and even under tree roots.
Eastern massasauga rattlesnake	*Sistrurus catenatus*	Threatened	Wet areas including low areas along rivers and lakes, moving to adjacent uplands during the summer
Prairie bush clover	*Lespedeza leptostachya*	Threatened	Found only in the tallgrass prairie region
Western prairie fringed orchid	*Platanthera praeclara*	Threatened	Occur most often in mesic to wet unplowed tallgrass prairies and meadows but have been found in old fields and roadside ditches.
Eastern prairie fringed orchid	*Platanthera leucophaea*	Threatened	Mesic to wet prairies and meadows, marsh edges, or even bogs; requires grassy habitat with little to no woody encroachment
Iowa Pleistocene snail	*Discus macclintocki*	Endangered	Leaf litter of special cool and moist hillsides or algific talus slopes.

DESCRIPTION OF THE PROPOSED ACTIONS

The District is preparing a Feasibility Report with Integrated Environmental Assessment (EA) for implementation of the Project. The report will describe the existing conditions, future without Project conditions, alternative evaluation, and effects of the TSP. The following sections from the draft Report provide information regarding the potential effects of restoration activities planned within Steamboat Island proper, Grant Slough, and the West SE Island. The aquatic diversity, forest diversity, and SSP measures are listed as separate measures because they are distinct habitat types. However, these measures are intertwined as material used from mechanical excavation of the aquatic diversity areas will be used for topographic diversity and SSP sites. Table 2 provides a summary of all excavation and placement quantities for the TSP.

Dredge cuts for aquatic diversity sites and access channels were designed to a 60-ft bottom width where practicable. In some locations, the bottom width is narrowed down to 30 ft to avoid excavating land above the water surface. Side slopes of the dredge cut were designed at 4H:1V. Excavation would be to 8ft below flat pool, or elevation 563.2ft NAVD88.

Forest diversity sites were selected based on current vegetation quality and the proximity to potential dredge cut locations, as well as accessibility with construction equipment. Sites will be raised to an elevation of 576.2ft NAVD88 and planted with tree species. SSP sites were determined based on presence of low value vegetation dominated by reed canary grass and suitability of that site to support SSP vegetation, as well as accessibility with construction equipment. Sites will be raised to an elevation of 573.1ft NAVD88 and planted with SSP species.

Island restoration and protection sites were selected to build off existing islands and restore island footprint that has been lost from erosion and inundation. These measures include a combination of open water and bankline placement of dredged material and stone protection.

Timber stand improvement (TSI) measures include tree plantings, thinning treatments, and non-desirable vegetation maintenance. It is estimated approximately 900 acres of active TSI strategies will be implemented in the next 10 years within the Project area.

Table 2: Excavation and Fill Data Summary

	Dredging		Placement		
Dredge Cuts & Placement Sites	**Length (linear ft)**	**Dredging Quantity (cy)**	**Stone Length**	**Capacity (cy)**	**Stone (TN)**
Steamboat Island (SI) Upper Lake	6,902	194,828	–	–	–
SI Lower Lake	5,758	170,158	–	–	–
Grant Slough Lake	3,377	87,704	–	–	–
Access to Grant Slough	3,017	10,721	–	–	–
Access to SE Island	372	855	–	–	–
Restore Upper SI (USI) Head	–	–	3,863	274,530	102,941
Northeast (NE) Bank	–	–	1,589	30,990	22,403
West Southeast (SE) Island	–	–	418	76,020	6,115
SI Upper Lake Placement Site	–	–		10,972	–
Grant Slough Placement 2	–	–		11,886	–
Grant Slough Placement 4 & 5	–	–		47,503	–
Grade Control Structure (GCS)	–	–	264	561	162
Grant Slough Placement 1 (SSP)	–	–	–	3,077	–
Lower Lake SSP	–	–	–	2,988	–
Totals in Draft TSP	19,426	464,266	6,134	458,527	131,622
Totals in Draft TSP (accounts for shrinking/bulking)	**19,426**	**510,692**	**6,134**	**504,380**	**131,622**

SPECIES STATUS IN THE ACTION AREA

The Higgins eye pearlymussel, sheepnose mussel, spectaclecase mussel, Indiana bat, and Iowa Pleistocene snail are federally-endangered species listed in the Project area, while the prairie bush clover, Western and Eastern prairie fringed orchids, Eastern massasauga, and northern long-eared bat are listed as federally-threatened species.

1. Higgins eye pearlymussel. Due to the presence of 6 live Higgins eye mussels recovered during a 2018 mussel survey, the TSP was revised to avoid and minimize impacts to federally-listed mussel species by removing the East SE Island from the Project footprint (Enclosure 2, SA5). A follow-up survey of the West SE Island and Grant Slough in 2019 yielded no federally-listed mussel species and revealed substrates high in shifting sand and/or flocculent silt, generally considered to be unsuitable habitat (Enclosure 3). Collectively, there is a low likelihood of Higgins' eye presence within the Project's revised footprint.

2. Sheepnose mussel. According to the most recent mussel survey (2019), no individuals of sheepnose were collected (Enclosure 3). Similarly, no sheepnose individuals were recovered during a 2018 survey of the wider Project area (Enclosure 2). A past survey conducted in 2006 resulted in one live sheepnose identified outside of the Project area, indicating a low probability of presence

3. Spectaclecase mussel. According to the most recent mussel survey (2019), no individuals of spectaclecase were collected nor preferred habitat encountered (Enclosure 3). Similarly, no spectaclecase individuals were recovered during a 2018 survey of the wider Project area (Enclosure 2). Past surveys have not resulted with any spectaclecase records near the Project area, indicating a low probability of presence.

4. Indiana and Northern long eared bats. Due to the existing ideal habitat for bat use and identified species of Indiana and Northern long eared bats from previous surveys conducted throughout Pool 14, presence is assumed within the Project area. Avoidance and minimization efforts in limiting tree clearing, including during the active season, will be implemented. Based on these efforts, the USFWS determined additional surveys will not be required at this time.

5. Eastern massasauga rattlesnake. The last identified presence of Eastern massasauga was reported adjacent to the Project area in 1999; however, the USFWS determined a survey was not required based on the lack of suitable habitat within the Project area.

6. Iowa Pleistocene snail. The species has not previously been recorded in the area nor does the Project area offer suitable habitat for establishment or survival.

7. Listed plant species. While potential habitat exists statewide in Iowa for the prairie bush clover, eastern prairie fringed orchid, and western prairie fringed orchid, none have previously been recorded in the Project area and the current state of invasive species domination limits the opportunity for establishment or survival.

EFFECTS OF THE PROPOSED ACTIONS

Construction activity would temporarily increase turbidity immediately downstream of the proposed dredge cuts and in-water construction. Utilizing mechanical dredging to build up topographic diversity sites and existing islands reduces impacts to the local water column and its associated aquatic communities. Although macroinvertebrate density and diversity is relatively low, temporary disruption and minor loss is expected to occur through dredging and rock placement. These areas should be recolonized shortly following construction. The PDT decided to use 2019 survey results to inform access dredging design and further avoid and minimize mussel impacts in the more densely inhabited areas of Grant Slough. Additionally, fish habitat (e.g., rock substrate, large woody debris) and mussel habitat (e.g., mixture of various sizes of river rock suitable as substrate for multiple mussel species) will be installed at the island protection sites and within aquatic diversity sites, providing immediate direct benefits to fish and mussels that inhabit the area in the form of increased habitat structure and function.

Recommendations for these measures were provided by the USFWS and IADNR and incorporated to the design.

The Project includes approximately 1.3 acres of tree clearing to access to topographic diversity sites in Grant Slough. Due to these activities, temporary disruptions to Indiana and Northern long eared bats may occur; however, the area designated for clearing is not anticipated to negatively affect primary roost trees, feeding corridors, and areas of high bat activity. The overall forested habitat which exists on Steamboat Island proper is approximately 1,674 acres. When compared to the number of acres potentially affected by the Project, the District determined it to be about 0.07% of the total. Any tree removal will be conducted October 1 – March 31 to avoid the bat maternity roosting season and all areas will be re-planted upon construction completion.

Corps' foresters will continue to implement TSI measures at various locations within the Project area to increase tree health, structural diversity and forest resilience (Enclosure 4). These measures include tree plantings, thinning treatments, and non-desirable vegetation maintenance. Disruption of the habitat during tree planting would be minimal. Post-planting and periodic operation and maintenance procedures, such as undesirable vegetation control through hand pulling or herbicide treatments, would have little impacts on the environment. Any required herbicide treatments would be applied by a licensed applicator using state and Federal standards, thus minimizing potential localized impacts. Estimated tree thinning prescriptions in the Project area are variable between management units and are described in further detail in the Report. All tree thinning efforts will be conducted October 1 – March 31 to avoid the bat maternity roosting season and trees marked to be cut or saved will be coordinated with the PDT prior to construction.

EFFECTS DETERMINATION AND CONSERVATION MEASURES

The TSP was revised to avoid and minimize impacts to federally-listed mussel species. The results from two survey events did not identify the three federally-endangered mussel species within the revised TSP footprint. In coordination with the USFWS, the 2019 survey results precluded the need for a Biological Assessment and the District determined the proposed Project *May Affect,* but is *Not Likely to Adversely Affect* the Higgins eye pearlymussel, due to the potential impacts from in-water rock and dredged material placement, as well as necessary access dredging (approximately 5.6 acres).

Tree clearing is minimal for the Project area and will be replanted following construction. Any tree removal will adhere to seasonal limitations to avoid the bat maternity roosting season. Corps' Foresters will continue to implement forest management measures (including TSI strategies) following construction of this Project, providing the bat community with habitat complexity and diversity through increased forage opportunities and potential roost tree production. In coordination with the USFWS, the District determined the proposed project

May Affect, but is *Not Likely to Adversely Affect* Indiana and Northern long eared bats by temporarily reducing the amount of potential roosting and foraging habitat and create short-term fragmented woodlands within the action area (approximately 1.3 acres).

In planning and coordination efforts, the District has taken the aforementioned conservation measures to minimize and avoid impacts to listed species for the Project. It is determined the proposed Project is not likely to adversely affect any threatened or endangered species or their critical habitat (Table 3). Therefore, the District is requesting conclusion of informal consultation, in compliance with the legal requirements set forth under Section 7 of the Endangered Species Act (15 U.S.C. 1536 (c)) and applicable guidance documents.

Table 3. Determination of Impacts from Proposed Modifications to Federally-endangered and -threatened Species

Species	Scientific Name	Status	Determination of Impacts
Indiana Bat	*Myotis sodalis*	Endangered	Not Likely to Adversely Affect
Northern Long-Eared Bat	*Myotis septentrionalis*	Threatened	Not Likely to Adversely Affect
Higgins Eye Pearlymussel	*Lampsilis higginsii*	Endangered	Not Likely to Adversely Affect
Sheepnose mussel	*Plethobasus cyphyus*	Endangered	No Effect
Spectaclecase mussel	*Cumberlandia monodonta*	Endangered	No Effect
Eastern massasauga	*Sistrurus catenatus*	Threatened	No Effect
Prairie Bush Clover	*Lespedeza leptostachya*	Threatened	No Effect
Western Prairie Fringed Orchid	*Platanthera praeclara*	Threatened	No Effect
Eastern Prairie Fringed Orchid	*Platanthera leucophaea*	Threatened	No Effect
Iowa Pleistocene snail	*Discus macclintocki*	Endangered	No Effect

Please provide any other comments, concerns, or questions you may have regarding this Project within 30 days of receipt of this letter. Address your responses to Ms. Davi Michl of our Environmental Planning Branch by telephone [redacted] in writing to our address above, ATTN: Environmental Planning Branch (Michl), or email: [redacted]

Sincerely,

Jodi Creswell

Jodi Creswell
Chief, Environmental Planning Branch

(RPEDN)
Enclosures (4)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Illinois & Iowa ES Field Office
1511 47th Avenue
Moline, Illinois 61265
Phone: (309) 757-5800 Fax: (309) 757-5807

IN REPLY REFER TO
FWS/ILIAFO
TAILS #03E18000-2020-I-0836

February 21, 2020

Jodi Creswell
Chief, Environmental Planning Branch
U.S. Army Corps of Engineers
Rock Island District
Attn: Davi Michl
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61201-2004

Dear Ms. Creswell:

This responds to your letter requesting concurrence from the Fish and Wildlife Service (Service) for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), dated January 22, 2020. The Steamboat Island HREP is part of the Upper Mississippi River Restoration (UMRR) Program and is located within Pool 14 of the Upper Mississippi River, extending along both sides of the navigation channel between river miles 502.5 and 508.0, Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. As part of the project, the U.S. Army Corps of Engineers, Rock Island District (District) has identified a tentatively selected plan (TSP) that incorporates refinements and conservation measures to minimize and avoid impacts to federally listed species, as your letter describes. You determined that the project may affect but is not likely to adversely affect (NLAA) the federally endangered Indiana bat (*Myotis sodalis*) and Higgins eye pearlymussel (*Lampsilis higginsii*), and the federally threatened northern long-eared bat (*Myotis septentrionalis*). This informal consultation addresses potential effects to the species in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*) and 50 CFR § 402 of our interagency regulations governing section 7 of the Act.

Multiple bat surveys have been conducted throughout the floodplain forests of Pool 14 in recent years. Specifically, a bat survey was completed in 2015 at the Beaver Island HREP, located approximately eight river miles upstream from the project area. The Beaver Island HREP survey identified both northern long-eared bats (acoustics and mist-netting) and Indiana bats (acoustics only). Additionally, a season-long acoustic survey conducted at the adjacent Princeton Wildlife Management Area identified use by both Indiana bats and northern long-eared bats in 2018; however, neither species was collected through mist-netting efforts. Due to the known presence of both the Indiana and northern long-eared bats within the project vicinity and the identification of potentially suitable habitat throughout the project area, we assume presence of these species throughout the project.

Project activities resulting in potential disturbance to Indiana and northern long-eared bat habitat include tree clearing to allow equipment access to the topographic diversity sites within the Grant Slough area and active timber stand improvement (TSI) practices. The TSP identifies approximately 1.3 acres of tree removal, which is roughly 0.07 percent of the total forested habitat available within the Steamboat Island complex. The tree removal, as proposed, will not result in fragmentation of bat roosting or foraging habitat and cleared areas will be replanted following the completion of construction. Recent tree inventories have identified potential roosting habitat throughout the remaining forested sections of the Steamboat Island complex, including trees that likely serve as primary or secondary roosts. Because the District proposes to complete this limited amount of tree clearing between October 1 and March 31, which is outside the bat active period, removal of unidentified maternity roost trees is unlikely to result in the incidental take of Indiana or northern long-eared bats. Further, the Service has identified certain incidental take of the northern long-eared bat resulting from tree removal as exempted from prohibition under the final 4(d) Rule of the Act (50 CFR 17).

TSI practices to be implemented across approximately 900 acres on Steamboat Island over the next ten years include thinning treatments, removal of non-desirable vegetation, and tree plantings. We anticipate thinning treatments, such as girdling, to benefit tree-roosting bats through the creation of increased snag habitat, canopy openings, and solar exposure. We further expect the removal of non-desirable vegetation within the understory to open up flight and foraging corridors to facilitate bat movement throughout the complex. The proposed tree plantings will consist of mast trees, including species which produce exfoliating bark, providing additional bat habitat as the trees mature. Additionally, proposed topographic diversity features include raising the ground elevation in areas currently dominated by low quality vegetation, such as the invasive reeds canary grass. Desirable tree species will be planted in these elevated areas, expanding upon existing forest habitat and increasing the quality, health, and resilience of the stand. Collectively, we expect these activities to result in positive, long-term benefits for potential roost tree production, foraging habitat, and habitat diversity. All tree thinning efforts will be completed outside of the bat maternity season, between October 1 and March 31, and any required herbicide treatments will be applied by a licensed applicator using state and federal standards, thus minimizing potential localized impacts.

For the reasons stated above, **we concur with your determination that the project may affect but is not likely to adversely affect** Indiana bats and northern long-eared bats.

Project features and activities resulting in disturbance to aquatic habitats include the mechanical dredging of dredge cuts for increased aquatic diversity sites and access channels. The TSP identifies approximately 510,692 cubic yards of proposed dredging. Additionally, the TSP proposes to restore acreage within the historic footprints at the head of Steamboat Island and the west southeast island that has been lost through erosion and inundation. Island footprint restoration and will include a combination of open water and bankline placement of dredged material and installation of approximately 504,380 cubic yards of stone protection to stabilize these sites and other areas of bankline erosion throughout the project area.

Freshwater mussel surveys were completed within the project area in 2018 and 2019. A combination of quantitative and qualitative sampling was conducted within most proposed project feature areas during the 2018 survey, with survey work confined to qualitative "spot" sampling within Grant Slough and the southeast islands. This effort identified six live Higgins eye pearlymussels between the Illinois bankline and the east southeast island. The east southeast island is located within the Cordova Higgins eye essential habitat area (EHA), spanning the Illinois bankline between approximate river miles 503-505.5. The District subsequently altered the project area boundaries to omit the east southeast island and areas within the EHA to minimize and avoid impacts to the Higgins eye pearlymussel.

A follow-up mussel survey was completed in 2019, to further assess the mussel resources within Grant Slough and surrounding the west southeast island. There were no federally listed mussel species identified as part of this effort. However, both survey efforts identified a species-rich assemblage of mussels within Grant Slough, with pockets of higher density areas. Together, these surveys will be used to inform the alignment of the access channel dredging within Grant Slough to avoid and minimize impacts to areas of higher mussel densities.

Further, the integration of rip rap, large woody debris, and a mixture of various sizes of river rock will provide suitable substrate and habitat features for freshwater mussel resources and their respective host fish. Collectively, we expect these features to increase the aquatic habitat structure and function within the project area.

For the reasons stated above, **we concur with your determination that the project may affect but is not likely to adversely affect** Higgins eye pearlymussels.

Two additional federally endangered mussel species are known to have ranges overlapping the project area, the sheepnose mussel (*Plethobasus cyphyus*) and the spectaclecase mussel (*Cumberlandia monodonta*). Historic surveys have found sheepnose within the Cordova EHA; however this species has not been identified in survey efforts since one fresh dead and one live individual were found in 2005 and 2006, respectively. Surveyors employed spectaclecase-specific survey methods where potentially suitable habitat was encountered during the 2018 and 2019 survey efforts within the project area; however, efforts resulted in the collection of no live specimens or shells.

The District made no effect determinations for the sheepnose mussel, spectaclecase mussel, eastern massasauga (*Sistrurus catenatus*), prairie bush clover (*Lespedeza leptostachya*), western prairie fringed orchid (*Platanthera praeclara*), eastern prairie fringed orchid (*Platanthera leucophaea*), and the Iowa Pleistocene snail (*Discus macclintocki*). The Illinois-Iowa Ecological Services Field Office has no regulatory or statutory authority for concurring with "no effect" determinations. However, we recommend you maintain a written record of your "no effect" determination and include it in your decision record. An example "no effect" memo can be found on our website at http://www.fws.gov/midwest/endangered/section7/s7process/letters.html.

Finally, the Service removed bald eagles from protection under the Act on August 8, 2007. However, they remain protected today under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (Eagle Act). The Eagle Act prohibits take which is defined as, "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb" (50 CFR 22.3). We define disturb in regulations as, "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." An eagle nest has been known to exist within the project boundaries, at the head of Steamboat Island; however, it is suspected that the nest may have fallen as a result of flood impacts in 2019. The status of this nest should be confirmed prior to the onset of construction activities. Should potential disturbance to eagles or eagle nests be identified, consultation should be initiated.

This letter provides comments under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and the Endangered Species Act of 1973, as amended. Should you modify the project or if new information indicates endangered species may be affected, consultation should be initiated. Thank you for the opportunity to provide comments. If you have any additional questions or concerns, please contact please contact Sara Schmuecker of my staff at [redacted]

Sincerely,

Kraig McPeek
Field Supervisor

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Illinois - Iowa Field Office
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Moline, Illinois 61265
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IN REPLY REFER TO:
FWS/ILIAFO
TAILS: 03E18000-2017-CPA-0011

April 3, 2020

Colonel Steven M. Sattinger
District Engineer
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Sattinger:

This letter constitutes our ***draft*** Fish and Wildlife Coordination Act Report (dFWCAR) for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) and is intended to provide compliance with Subsection 2(b) of the Fish and Wildlife Coordination Act, (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); Section 7 of the Endangered Species Act of 1973, as amended; the National Environmental Policy Act; and the Migratory Bird Treaty Act (40 Stat, 755, as amended; 16 U.S.C. 703 et seq. The Steamboat Island HREP is a component of the Upper Mississippi River Restoration (UMRR) Program authorized by Section 1103 of the Water Resources Development Act (WRDA) of 1986. The interagency planning team designed the Steamboat Island HREP to further the mission of the UMRR Program: "To work within a partnership among federal and state agencies and other organizations; to construct high-performing habitat restoration, rehabilitation projects; to produce state-of-the-art knowledge through monitoring, research, and assessment; to engage other organizations to accomplish the UMRR Program's vision."

The Steamboat Island HREP is located in Pool 14 of the Upper Mississippi River (UMR), river miles (RM) 502.5 through 508.0, Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. The U.S. Fish and Wildlife Service (USFWS) is the Sponsor for the Steamboat Island HREP. All project lands are owned by the USFWS and the U.S. Army Corps of Engineers, Rock Island District (District), and are managed as part of the USFWS' UMR National Wildlife and Fish Refuge (NWFR) through a cooperative agreement between the USFWS and the District. The scope of this report focuses on proposed project measures that will increase the quality and quantity of the bottomland hardwood forest, aquatic habitat, island topography, and backwater and interior wetland habitat; provide important linkages between similar habitats in Pool 14; and enhance overall resource values. The Steamboat Island HREP is consistent with

Sponsor and interagency management goals and was planned for the benefit of resident and migratory birds, fish, and other wildlife.

STATE AGENCY COORDINATION

The USFWS prepared this letter in cooperation with the Iowa Department of Natural Resources (IADNR) and the Illinois Department of Natural Resources (ILDNR), with coordinated comments and recommendations presented regarding the construction of the Steamboat Island HREP. Significant coordination between the USFWS, IADNR, ILDNR, and District resulted in a thoroughly reviewed and critiqued project with design providing optimum benefits to fish and wildlife resources, while protecting and enhancing unique and diverse resources within the project boundaries. The multi-agency coordination effort has demonstrated the value of this project towards maintaining a high quality UMR ecosystem while avoiding adverse impacts.

PREVIOUS REPORTS AND STUDIES

Refer to Section E of the *draft* UMRR Feasibility Report with Integrated Environmental Assessment for the Steamboat Island HREP (*draft* Feasibility Report hereafter), dated January 2020, for a full discussion of prior studies, reports, and existing water projects applicable to the Steamboat Island HREP.

DESCRIPTION OF THE PROJECT AREA

Pool 14 is the 29.2-mile segment of the UMR extending upstream from Lock and Dam 14 (RM 493.3) at Le Claire, Iowa, to Lock and Dam 13 (RM 522.5) at Fulton, Illinois. Pool 14 has a surface area of approximately 10,580 acres. The Pool 14 floodplain is natural, without levees, with the exception of the northern one-third of the Pool. Sections of levees extend downstream of Lock and Dam 13 from approximate RM 510.0 to 522.5, bordering Fulton, Illinois, and Clinton, Iowa, in addition to a small approximately two mile-long segment bordering Albany, Illinois. The majority of the riparian environment within Pool 14 consists of agricultural, residential, urban, and industrial development with interspersed undeveloped areas. The upper and middle portions of the pool consist of braided islands, side channels, and backwaters, extending downstream to the head of the former Rock Island rapids at the Fulton-Rock Island gorge. The gorge restricts the lower portion of the pool, resulting in a lack of side channels and backwater habitats. The largest tributary to the pool is the Wapsipinicon River (Iowa), which enters the Pool immediately upstream of Steamboat Island, within the project area at approximate RM 506.8. Smaller tributary streams include Bud Creek (Iowa), Spring Creek (Illinois), and the Cedar Creek (Illinois).

The USFWS owns the majority of public lands within the Pool 14 floodplain and manages these areas as part of the UMR NWFR, Savanna District. Additional lands are held by the District under the Nine-Foot Navigation Project and the State of Iowa. The Princeton Refuge HREP is located within the State of Iowa's Princeton Wildlife Management Area, downstream from the Wapsipinicon River confluence and adjacent to the Steamboat Island HREP (RM 504.0R through 506.5R). The Princeton Refuge HREP was completed in 1995 under the UMRR Program and continues to be managed by the IADNR.

A distinguishing feature of Pool 14 is the presence of the Exelon Generation Co. nuclear plant (Exelon) located in Cordova, Illinois, directly across the channel from the Wapsipinicon River confluence (RM 506.5). Exelon operates under a Section 10(a)(1)(B) incidental take permit for the federally endangered Higgins eye pearlymussel (*Lamsilis higginsii*) and sheepnose mussel (*Plethobasus cyphyus*), due to the generation of a thermal plume discharge into the UMR at RM 506.4. Increased thermal conditions have been documented to negatively impact the reproduction, feeding, growth, and burrowing behavior of freshwater mussels; therefore, as part of the Habitat Conservation Plan and incidental take permit, freshwater mussel monitoring has been conducted throughout the pool over multiple years. One of the monitoring sites is located at the upper end of Steamboat Slough (RM 505.5), within the Project area. This monitoring site is the closest downstream site to the warm water effluent mixing zone. The dominate species within this bed are within the Ambleminae subfamily, a group of mussels known to have a somewhat higher thermal tolerance comparatively; however, individuals of Higgins eye pearlymussel have been found within the bed on occasion. Overall, the Steamboat Slough bed has maintained species richness and densities throughout the long-term monitoring period, indicating the effects of the Exelon warm water discharge are unlikely to significantly influence the project area (Exelon Generation, 2009). Additionally, Exelon continues to conduct pool-wide fish surveys (began in 1971), and is home to the only privately-owned fish hatchery on the Mississippi River, continuing to raise and stock millions of fish species into the UMR.

Human activity over the past two centuries within the UMR basin floodplain and channel, including the construction of the lock and dam system, has contributed to the alteration of the hydrology and topography historically present throughout the Upper Mississippi River valley (USACE, 2012). Such conditions have adversely impacted the biological resources of the river through reduction of habitat diversity. Over time, the impacts of channel modification have contributed to a decrease in habitat structure diversity, bottomland hardwood tree regeneration, aquatic backwater and secondary channel habitats, and the biota dependent on these habitats. Specific to the Steamboat Island area, the construction of Lock and Dam 13 and Lock and Dam 14 in 1939, and other anthropogenic influences have resulted in altered flood regimes, including high flood pulses and the reduction of historically common low flow periods. Furthermore, navigation infrastructure and floodplain development have collectively resulted in increased water levels, flow, and sedimentation leading to reduced diversity, quality, and acreage of aquatic habitat, native floodplain forest, and ephemeral wetlands through succession. Sedimentation has prevented access to and connectivity between many backwater areas, further reducing their functionality. These types of backwater areas provide habitat for multiple life-stages of various fish species, but are particularly ideal over-wintering habitat for certain fishes, including centrarchid species such as bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), and white crappie (*P. annularis*).

The altered flood pulse has resulted in year-round flooding of floodplain forests adjacent to the navigation channel, supporting the proliferation of flood-tolerant tree species, such as silver maple (*Acer saccharinum*), and invasive herbaceous plants, such as reed canary grass (*Phalaris arundinacea*). Such conditions result in a loss of flood intolerant hardwood mast tree species diversity and recruitment, with a migration towards a monotypic forest. Consequently, a loss of nut producing hardwood trees has been observed, which are a critical food source for many species of floodplain wildlife.

Furthermore, the altered channel and flow velocities have led to the erosion and loss of islands throughout Pool 14. Island loss results in increased wind fetch further eroding and exposing previously protected habitats, such as mussel beds and overwintering areas for fish. Since the construction of Lock and Dams 13 and 14, Steamboat Island proper has been reduced by more than 80 acres, with an average of 0.3 acres of loss per year over the past 65 years (USACE 2020). Similar conditions have been experienced at other islands throughout the Pool. Since the start of this study in 2017, visual observations have confirmed active erosion at Steamboat Island proper and two small unnamed islands located across the channel from Steamboat Island, referred to as the "East and West Southeast Islands," including trees falling off banks into the river as a result of erosion and bank undercutting. The loss of island acreage results in increased wind fetch further eroding and exposing previously protected habitats, such as mussel beds, wetlands, and overwintering backwater areas for fish. These stressors are likely to continue system wide, as will the decline of the quality of aquatic, wetland, and floodplain habitat. This project provides an opportunity to improve the quality and diversity of critical habitats within the Steamboat Island complex.

Areas considered as part of the Steamboat Island HREP and described as the project area include Steamboat Island, Steamboat Slough, the adjacent secondary channel Grant Slough complex, a small island in the southeast portion of the project area (West Southeast Island), and the forested areas north and south of the Wapsipinicon River confluence. The project area contains approximately 2,013 acres of floodplain habitat. This acreage includes approximately 1,674 acres of floodplain forest habitat, 292 acres of emergent wetland habitat, and 47 acres of predominantly scrub-shrub/pollinator habitat (USACE 2020). Additionally, the project area includes approximately 614 acres of lotic and lentic aquatic habitat. The USFWS does not conduct active habitat management within the Project area; however, the District has retained forestry management responsibility on fee title lands. The District continues to conduct small-scale forestry management actions.

The areas of quality habitat persisting throughout the Steamboat Island and Grant Slough complex area support a diverse assemblage of fish and wildlife resources, including UMR NWFR identified Priority Resources of Concern (USFWS 2019), state and federally listed threatened and endangered species, migratory birds, and other protected species. Additional information on resources and recent surveys can be found in Section II of the *draft* Feasibility Report.

PROJECT OBJECTIVES

The goals of the Steamboat Island HREP are to maintain, enhance, and restore quality habitat for desirable native plant, animal, and fish species and maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem. These goals were developed in accordance with the UMR NWFR management plan, with input provided by state and federal biologists. Objectives, as presented in the *draft* Feasibility Report to meet these goals include:

1. enhance and restore areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest, as measured in forested acres suitable to support hard mast species and structure, age, and species composition;

2. increase year-round aquatic habitat diversity, as measured by acres and limnophilic native fish use of overwintering habitat, as this habitat is the most limiting of seasonal habitats;

3. restore acreage and topography of islands and protect from erosion within the project area, as measured by acres; and

4. protect existing backwater habitat from sediment deposition and enhance backwater and interior wetland areas, as measured by acres of backwater and survivability of scrub-shrub/pollinator habitat.

Although the Steamboat Island HREP is a component of the UMRR Program, the project also supports several additional efforts identifying ecosystem restoration needs and priorities across systemic, regional and local scales. Of particular note, the Steamboat Island HREP supports resource management goals and objectives identified by the UMR NWFR through their Habitat Management Plan (HMP) (USFWS 2019). Priority resources of concern identified within the HMP that are relevant and could benefit from the project include: Midwestern wooded swamps and floodplains, red-shouldered hawk, dabbling ducks, prothonotary warbler, cerulean warbler, transient neotropical migrant passerines, secretive marsh birds, tree-roosting bats, limnophilic and fluvial-dependent native mussels, limnophilic native and migratory fluvial-dependent native fish, and native invertebrate pollinators. A full summary of relevant resource management plans is provided in Section III(C) of the *draft* Feasibility Report.

DISCUSSION OF SELECTED PROJECT FEATURES

The interagency planning team identified and considered more than 40 potential project features to support the objectives identified for the Steamboat Island HREP. Project features considered were categorized under the following measures: aquatic habitat diversity, topographic diversity for floodplain forest habitat, topographic diversity for scrub-shrub/pollinator habitat, island restoration and protection, small island creation, flow diversity, forest habitat measures, incorporation of mussel habitat substrate, marine traffic management through enforcement and mooring cell creation, sediment load management, complex connectivity, pool-wide drawdown, and real estate acquisition. Refer to Section IV of the *draft* Feasibility Report for a full list of the identified project measures and descriptions. Measures were further assessed by the planning team with eight measures and their dependencies being retained for further evaluation. The planning team identified two considerations and rules to inform combination of the measures into alternatives: (1) the grade control structure in the cut-through channel is necessary with the proposed excavation in the Lower Lake Aquatic Diversity measure to aid in the reduction of sediment transfer into the backwater system, and (2) timber stand improvement (TSI) will be included in all alternatives. The proposed features were then combined to generate more than 100 possible alternatives. Features including the restoration and protection of the head of Steamboat Island and all aquatic diversity measures within Steamboat Island proper were determined to be essential to the restoration of the project area and of highest priority for the

Sponsor and project partners. Therefore, alternatives that did not include both of these measures were not carried forward for further consideration. Additional considerations and evaluation by the planning team resulted in a final array of nine alternatives, including the No Federal Action alternative (or future without project), being carried forward.

A habitat benefit evaluation was conducted to evaluate the effects of the proposed project measures on aquatic and floodplain habitat quantity and quality. The assessment was conducted by an interagency team that included representatives from the USFWS, IADNR, ILDNR, and the District. Habitat Evaluation Procedures (HEP) and Hydraulic Engineering Center Ecosystem Functions Model (HEC-EFM) were utilized to quantify aquatic and floodplain benefits, respectively. The HEP are based on the assumption that habitat for selected wildlife species can be described by a Habitat Suitability Index (HSI). This index value (from 0.0 to 1.0) is multiplied by the area of applicable habitat to obtain Habitat Units (HUs). Changes in HUs will occur as a habitat matures naturally or is influenced by development. Average annual habitat units (AAHUs) for each species are typically calculated to reflect expected habitat conditions over a 50-year project life. To assess the change throughout the life of the project, the planning team identified target years where a change in the habitat variables may be noticed. HEC-EFM further informed the evaluation by identifying the appropriate elevation threshold for each habitat type, allowing respective acreages to be calculated and compared between existing, future without project, and future with project conditions.

Aquatic benefits were quantified through the use of Engineering Circular 1150-2-412, *Assuring Quality of* Planning Models and the Upper Mississippi River System Overwintering Bluegill and Walleye Habitat Suitability Index (HIS) Models (HEP; USFWS 1980). Floodplain benefits were quantified through the use of the Gray Squirrel and Yellow Warbler HIS Models (HEP; USFWS 1980). Additional discussion of these evaluation procedures is provided in Section V(B) and Appendix D of the *draft* Feasibility Report. Four of the nine alternatives were identified as “best buy” options and were further assessed by the planning team. Of these, Alternative #27 was determined to best meet the defined project objectives, the Sponsor’s objectives, and other agency identified goals. Alternative #27 was ultimately recommended by the planning team as the preferred alternative and carried forward as the TSP (Table 1).

Table 1: Tentatively Selected Plan (TSP)

Project Feature/Location	Description	Objective(s)
Steamboat Island Upper Lake Steamboat Island Lower Lake NW Grant Slough Lake	Aquatic Diversity: Increase aquatic diversity in the project area backwaters by excavation. Where appropriate, additional fish and mussel habitat may be incorporated to bring further benefit to the species that occupy the project area.	Increase year-round aquatic habitat
Upper Steamboat Island Head NE Bank Steamboat Island Upper Lake Placement Site 1 Grade Control Structure (GCS) Grant Slough Placement Site 2 Grant Slough Placement Sites 4 and 5	Topographic Diversity (Forestry): Restore topographic diversity throughout portions of the project area by increasing existing elevations and planting hard mast tree species	Enhance and restore areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest.
Lower Lake Grant Slough Placement Site 1	Topographic Diversity (SSP): Restore topographic diversity throughout portions of the project area by increasing existing elevations and planting shrubs, understory plants, and buffer species.	Enhance and restore areal coverage and diversity of scrub-shrub/pollinator (SSP) habitat.
West Southeast Island Steamboat Island proper	Island Restoration and Protection: Restore and protect island acreage on portions of Steamboat Island proper and the whole West Southeast Island by placing stone protection and dredged material, then planting with trees.	Restore island acreage and protect from erosion, protect existing backwater habitat from sediment deposition, and enhance backwater and interior wetland areas.
Forest Habitat (TSI) at 11 sites, contained within three units within the Project boundaries (approx.. 900 acres)	Timber Stand Improvement (TSI): Conduct tree thinning, planting, and invasive species management treatments to increase floodplain forest age, structure, and species diversity.	Enhancing and restore diversity of forest stands and habitat and increase diversity of bottomland hardwood forest.

DISCUSSION OF FUTURE WITHOUT AND WITH PROJECT

To better compare and evaluate project features, the planning team used professional judgement and experience to apply a number of general and site-specific assumptions. These assumptions allow the team to extrapolate site conditions 50 years into the future within the project area and vicinity and compare the future with and without project conditions. These assumptions can be found in Appendix C of this report. The primary factors identified to affect future conditions of the project area include sedimentation, backwater lake water quality, flood inundation and duration, and island erosion.

Overwintering Fish Habitat

The aquatic habitat within the project area is comprised of main channel border, interconnected side-channels, and backwater areas. Collectively, these areas comprise approximately 127 acres of lentic and 487 acres of lotic aquatic habitat (USACE 2020). Continued bankline erosion and island dissection with the project area have allowed flow to enter isolated backwater habitats, increasing connectivity and carrying sediment into the backwater lakes, reducing their depth and quality. Sedimentation rates within the Steamboat Island HREP boundaries were monitored at four locations between 1984 and 2000 by the IADNR. As provided in Section II(K) of the *draft* Feasibility Report, sedimentation rates were observed to be dynamic, ranging from -0.8 inches per year (erosion) to 2.2 inches per year (deposition). Overall, sedimentation trended towards deposition, with an estimated overall rate of 0.4 inches per year. These changes are anticipated to result in the continued degradation of off-channel lacustrine fisheries habitat and succession of aquatic areas to flood tolerant herbaceous species, such as reed canary grass.

Changes in water quality and temperature would occur with additional sedimentation. Key factors influencing overwintering habitat and water quality conditions include dissolved oxygen, temperature, and water velocities. Baseline water quality monitoring of one site within the Steamboat Island complex interior was initiated in 2014. Two additional lentic habitat monitoring sites were added in 2017. These recent surveys have identified backwater areas within the project to experience intermittent high temperatures in the summer and occasional low dissolved oxygen (DO) levels in the winter, with existing suitable overwintering habitat limited to approximately 0.14 acres (USACE 2020). Overall, the existing aquatic habitat lacks adequate overwintering conditions (i.e., depth and flows) important for year-round habitat functioning.

The Bluegill Habitat Suitability Index (HSI) model (Stuber et al., 1982) was selected to assess the existing, future without project, and future with project backwater aquatic habitat conditions on the overwintering centrarchid community. Without action, the current sedimentation rates indicate the overwintering fish habitat within the Steamboat Island proper complex will likely be reduced from the existing 0.14 acres to zero acres within 10 years from the present (USACE 2020). Dredging of the Steamboat Island and Grant Slough complex backwater lakes and access channels is expected to benefit local fish communities by providing access to backwater overwintering habitats with depths conducive to supporting ideal dissolved oxygen and temperature profiles.

Additionally, installation of the GCS within the Steamboat Island cut-through channel and elevation and protection of the NE Bank will aid in the reduction of sediment transfer throughout the Steamboat Island complex interior and into the backwater lakes and wetlands system and further restore ecosystem function. Although slowed rates of sedimentation will likely persist, adequate depths and acreage are expected to be maintained, with these features continuing to provide long term benefits to backwater and overwintering fish communities throughout the 50-year life of the project. Further, the potential integration of large woody debris may provide additional suitable substrate and habitat features for backwater fish.

Mussel Habitat

Islands within the Steamboat Island HREP boundary have experienced significant erosion with degraded geomorphologic features, structure, and function. Of particular importance are the Southeast Islands which border an Essential Habitat Area (EHA) for the Higgins eye pearlymussel, spanning the Cordova, Illinois bankline between RM 503-505.5. These islands have been eroding at a rate of approximately 0.14 acres per year, exposing the Cordova EHA mussel bed to main channel flows (USACE 2020). The Cordova EHA mussel bed is known to harbor more than 23 freshwater mussel species with an average density of 10 live mussels per square meter (Section IID, *draft* Feasibility Report). This unique mussel resource was identified to extend into the Steamboat Island HREP, with more than 27 species of mussels found during a 2018, survey of the project area (ESI 2018). The Southeast Islands and Steamboat Island banklines provide for flow and structure diversity, resulting in habitat benefits for both the local mussel resources and their respective host fish species. At the current rate of erosion, the West Southeast Island is expected to completely disappear within the next few years, further reducing aquatic habitat structure diversity within the project area and potentially exposing and negatively impacting the surrounding mussel community.

The Walleye HSI model (McMahon et al., 1984) was selected by the interagency planning team to assess the existing, future without project, and future with project aquatic habitat conditions of riverine components. This model was selected in the absence of an approved mussel model to predict the Steamboat Island HREP effects on the potential occupation of the riverine project features by the federally endangered Higgin's-eye pearlymussel and common generalist mussel species through occupation by walleye host individuals. Installation of bankline stabilization features and mussel substrate into areas currently experiencing high erosion, as modeled for the West Southeast Island, is expected to result in an initial decrease in habitat quality as the substrate is established. Installation of mussel habitat substrate in conjunction with bankline stabilization features will provide approximately one acre of aquatic habitat benefits at the West Southeast Island, including reduction of wind fetch and erosion effects, long-term availability of stable substrates for the mussel community to occupy, and increased habitat structure and cover for host fish and other riverine fish species. Further, protection of the island may result in continued island growth through accretion, further extending benefits for the mussel and fish community.

Floodplain Forest and Scrub-Shrub/Pollinator (SSP) Habitat

River flood stages, and the resulting inundation of floodplain forest areas lacking topographic diversity, have increased since installation of the UMR lock and dam system, and have continued to increase since as a result of changing hydraulic conditions. Specifically, average flood stage elevations have increased approximately 0.3 feet between the 30-year monitoring periods of

1957-1986 and 1987-2016, within the vicinity of the Steamboat Island HREP (USACE 2020). Increased flood height, frequency, and duration have resulted in the displacement of tree stands of diverse species and age towards even-aged stands of flood tolerant tree species and invasive herbaceous plants. The Steamboat Island complex contains approximately 2,013 acres of floodplain habitat. This acreage includes approximately 1,674 acres of floodplain forest habitat, 292 acres of emergent wetland habitat, and 47 acres of predominantly scrub-shrub/pollinator habitat (USACE 2020). Roughly half of the Steamboat Island HREP is at an elevation suitable for hard-mast tree growth. A 2018 survey of the project forests identified eighteen tree species in the overstory, dominated by flood-tolerant silver maples (*Acer saccharinum*). Overall, desirable hard-mast tree stands were documented to be old, exceeding 80 years of age, with limited regeneration in the understory. As these even-aged stands continue to age and reach mortality, the resulting canopy openings and lack of tree regeneration facilitate the spread and dominance of non-desirable herbaceous vegetation, such as reed canary grass (*Phalaris arundinacea*). Conversion of habitat from floodplain forests to non-desirable herbaceous vegetation has recently been observed within the Steamboat Island HREP boundaries, with 35 acres of the existing scrub-shrub/pollinator (SSP) habitat being dominated by reed canary grass. A key component of the Steamboat Island HREP includes preserving areas of unique and diverse patches of forest while restoring the surrounding areas of non-desirable vegetation. Restoration of topographic diversity throughout the project includes increasing existing elevations and planting hard mast tree species, shrubs, understory plants, and buffer species. The planning team targeted areas of undesirable vegetation (reed canary grass) to convert to higher elevation areas capable of supporting hard-mast trees and SSP vegetation while avoiding impacts to floodplain forest resources

The Yellow Warbler HSI model (Schroeder, 1982) was used to assess pioneer/early successional floodplain forest habitat, while the Grey Squirrel HSI model (Allen, 1987) was used to assess mast tree habitat. Due to the topographic diversity features specifically targeting existing reed canary grass monoculture areas with low habitat value, the existing and future without conditions provide no habitat benefits. Following implementation of topographic diversity features and plantings of diverse species of hard mast trees and SSP vegetation, benefits are projected to remain low initially, as the vegetation becomes established, followed by an increase until full benefits are realized. Changes in floodplain forest species and age structure composition under future with-project conditions are projected to improve as existing diverse patches of hardwood mast tree species are allowed to regenerate in response to the raised elevation of surrounding areas above that of frequent and prolonged inundation. Proposed conservation measures, as identified in the *draft* Feasibility Report, include TSI activities for over 900 acres within the Steamboat Island HREP boundaries. TSI will include continued tree thinning treatments, plantings, and invasive species management resulting in maintained high habitat quality throughout the life of the project. Collectively, these activities are expected to result in positive long-term benefits for birds, bats, pollinators and other wildlife species, including increased foraging habitat, production of potential roost tree habitat, and increased overall habitat diversity. Further, the positioning of Pool 14 within the Mississippi River Flyway, one of the four major migratory flyways in North America, will result in improvements made to Steamboat Island HREP's floodplain habitats having the potential to benefit a significant number of migratory bird species.

THREATENED AND ENDANGERED SPECIES

To facilitate compliance with Section 7 of the Endangered Species Act of 1973, as amended, Federal agencies are required to obtain information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed action through the USFWS' Information for Planning and Consultation (IPaC) website. The following is a list of federally listed species with ranges within Clinton and Scott Counties, Iowa, and Rock Island County, Illinois (Table 2).

Table 2. List of Federal Threatened and Endangered Species for Clinton and Scott Counties, Iowa, and Rock Island, Illinois.

Common Name	**Scientific Name**	**Listing Status**	**Habitat**	**Classification**
Higgins eye pearlymussel	*Lampsilis higginsii*	Endangered	Usually found in deep water with moderate currents and gravel substrate.	Freshwater Mussel
Sheepnose mussel	*Plethobasus cyphyus*	Endangered	Found in large rivers and streams in areas of moderate currents upon coarse sand and gravel substrate.	Freshwater Mussel
Spectaclecase mussel	*Cumberlandia monodonta*	Endangered	Found in sheltered microhabitats within large rivers where the current is slow. Occurs across a variety of substrates.	Freshwater Mussel
Indiana bat	*Myotis sodalis*	Endangered	Winter: hibernate in caves and mines. Summer: roost under loose tree bark on dead or dying trees.	Bat
Northern long-eared bat	*Myotis septentrionalis*	Threatened	Winter: hibernate in caves and mines. Summer: found in wooded habitat; roost singly or in colonies underneath bark, in cavities or in crevices of both live trees and snags. Males and non-reproductive females may also roost in cooler places, such as caves and mines.	Bat
Prairie bush clover	*Lespedeza leptostachya*	Threatened	Found throughout tallgrass prairie region of the Upper Mississippi River valley.	Plant
Western prairie fringed orchid	*Platanthera praeclara*	Threatened	Found in mesic to wet unplowed tallgrass prairies and meadows, but have also been found in old fields and roadside ditches.	Plant
Eastern prairie fringed orchid	*Platanthera leucophaea*	Threatened	Found in mesic to wet unplowed tallgrass prairies and meadows, but have also been found in old fields and roadside ditches.	Plant
Iowa Pleistocene snail	*Discus macclintocki*	Endangered	Found in approximately 30 sites in Iowa and Illinois in leaf litter of cool and moist algific talus slope hillsides.	Snail
Eastern Massasauga	*Sistrurus catenatus*	Threatened	Found in wet areas including wet prairies, marshes and low areas along rivers and lakes. In many areas massasaugas also use adjacent uplands during part of the year. They often hibernate in crayfish borrows but may be found under logs and tree roots or in small mammal burrows.	Reptile

The USFWS concurred that implementation of the project and conservation measures as presented in the ***draft*** Feasibility Report, is "not likely to adversely affect" any known federally listed threatened or endangered species. Please refer to the USFWS' concurrence letter dated February 21, 2020, for further discussion (Appendix A). A summary of specific species concerns and conservation measures agreed upon through the planning process and ESA Section 7 informal consultation follows.

Higgin's-eye pearlymussel, Sheepnose and Spectaclecase Mussels
Project features and activities resulting in disturbance to aquatic habitats include the mechanical dredging of dredge cuts for increased aquatic diversity sites and access channels. The TSP identifies approximately 510,692 cubic yards of proposed dredging. Additionally, the TSP proposes to restore acreage within the historic footprints at the head of Steamboat Island and the West Southeast Island that has been lost through erosion and inundation. Island footprint restoration and will include a combination of open water and bankline placement of dredged material and installation of approximately 504,380 cubic yards of stone protection to stabilize these sites and other areas of bankline erosion throughout the project area.

Freshwater mussel surveys were completed within the project area in 2018 and 2019. A combination of quantitative and qualitative sampling was conducted within most proposed project feature areas during the 2018 survey, with survey work confined to qualitative "spot" sampling within Grant Slough and the Southeast Islands. This effort identified six live Higgins eye pearlymussels between the Illinois bankline and the East Southeast Island. The East Southeast Island is located within the Cordova EHA. The project area boundaries were subsequently altered to omit the East Southeast Island and areas within the EHA to minimize and avoid impacts to the Higgins eye pearlymussel.

A follow-up mussel survey was completed in 2019, to further assess the mussel resources within Grant Slough and surrounding the West Southeast Island. There were no federally listed mussel species identified as part of this effort. However, both survey efforts identified a species-rich assemblage of mussels within Grant Slough, with pockets of higher density areas. Together, these surveys will be used to inform the alignment of the access channel dredging within Grant Slough to avoid and minimize impacts to areas of higher mussel densities.

Further, the integration of rip rap, large woody debris, and a mixture of various sizes of river rock will provide suitable substrate and habitat features for freshwater mussel resources and their respective host fish. Collectively, we expect these features to increase the aquatic habitat structure and function within the project area.

Two additional federally endangered mussel species are known to have ranges overlapping the project area, the sheepnose mussel and the spectaclecase mussel. Historic surveys have found sheepnose within the Cordova EHA mussel bed; however, this species has not been identified in survey efforts since one fresh dead and one live individual were found in 2005 and 2006, respectively. Surveyors employed spectaclecase-specific survey methods where potentially suitable habitat was encountered during the 2018 and 2019 survey efforts within the project area; there were no live specimens or shells found.

Indiana bat and northern long-eared bat
Survey efforts have identified the federally endangered Indiana bat and the threatened northern long-eared bat within the floodplain forests of Pool 14 in recent years. Specifically, a bat survey was completed in 2015, at the Beaver Island HREP, located approximately eight river miles upstream

from the project area (Kiser et al. 2015). The Beaver Island HREP survey identified both northern long-eared bats (acoustics and mist-netting) and Indiana bats (acoustics only). Additionally, a season-long acoustic survey conducted at the adjacent Princeton Wildlife Management Area identified use by both Indiana bats and northern long-eared bats in 2018; however, neither species was collected through mist-netting efforts. Due to the known presence of both the Indiana and northern long-eared bats within the project vicinity and the identification of potentially suitable habitat throughout the project area, we assume presence of these species throughout the project.

Project activities resulting in potential disturbance to Indiana and northern long-eared bat habitat include tree clearing to allow equipment access to the topographic diversity sites within the Grant Slough area and active TSI practices. The TSP identifies approximately 1.3 acres of tree removal, which is roughly 0.07 percent of the total forested habitat available within the Steamboat Island complex. The tree removal, as proposed, will not result in fragmentation of bat roosting or foraging habitat and cleared areas will be replanted following the completion of construction. Recent tree inventories have identified potential roosting habitat throughout the remaining forested sections of the Steamboat Island and Grant Slough complex, including trees that likely serve as primary or secondary roosts. Because the District proposes to complete this limited amount of tree clearing between October 1 and March 31, which is outside the bat active period, removal of unidentified maternity roost trees is unlikely to result in the incidental take of Indiana or northern long-eared bats. Further, the Service has identified certain incidental take of the northern long-eared bat resulting from tree removal as exempted from prohibition under the final 4(d) Rule of the Act (50 CFR 17).

TSI practices to be implemented across approximately 900 acres on Steamboat Island over the next ten years include thinning treatments, removal of non-desirable vegetation, and tree plantings. We anticipate thinning treatments, such as girdling, to benefit tree-roosting bats through the creation of increased snag habitat, canopy openings, and solar exposure. We further expect the removal of non-desirable vegetation within the understory to open up flight and foraging corridors to facilitate bat movement throughout the complex. The proposed tree plantings will consist of mast trees, including species which produce exfoliating bark, providing additional bat habitat as the trees mature. Additionally, proposed topographic diversity features include raising the ground elevation in areas currently dominated by low quality vegetation, such as the invasive reed canarygrass. Desirable tree species will be planted in these elevated areas, expanding upon existing forest habitat and increasing the quality, health, and resilience of the stand. Collectively, we expect these activities to result in positive, long-term benefits for potential roost tree production, foraging habitat, and habitat diversity. All tree thinning efforts will be completed outside of the bat maternity season, between October 1 and March 31, and any required herbicide treatments will be applied by a licensed applicator using state and federal standards, thus minimizing potential localized impacts.

Additional Species

Five additional federally listed species, the eastern massasauga, prairie bush clover, western prairie fringed orchid, eastern prairie fringed orchid, and the Iowa Pleistocene snail, are known to occur in counties throughout Iowa and Illinois bordering Pool 14; however, suitable habitat for these species is not found within the project area. Although Eastern massasauga has historically been known to occur within the adjacent Princeton Wildlife Management Area, a live specimen has not been collected from this area since 1999. Further, the previously-occupied area is separated from potentially suitable habitat within the project area by habitat barriers; therefore, potential adverse impacts to the species as a result of the project are not anticipated.

Although no longer a listed species, bald eagles (*Haliaeetus leucocephalus)* continue to be protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Bald eagles winter along the Mississippi River, including Pool 14. Suitable perch trees where eagles can loaf and perch are numerous. An eagle nest has been known to exist within the project boundaries, at the head of Steamboat Island; however, it is suspected that the nest may have fallen as a result of flood impacts in 2019. The status of this nest should be confirmed prior to the onset of construction activities.

State of Iowa and Illinois threatened and endangered species that may occur within Scott and Clinton Counties, Iowa, and Rock Island, Illinois include the following (Table 3).

Table 3. State of Iowa and Illinois Threatened and Endangered Species Occurring in Scott and Clinton Counties, Iowa, and Rock Island County, Illinois.

Common Name	Scientific Name	Listing Status	Classification
Butterfly	*Ellipsaria lineolata*	Threatened	Freshwater Mussel
Spike	*Elliptio dilatata*	Threatened	
Creeper	*Strophitus undulatus*	Threatened	
Higgins Eye Pearlymussel	*Lampsilis higginsii*	Endangered	
Pistolgrip	*Tritogonia verrucosa*	Endangered	
Round Pigtoe	*Pleurobema sintoxia*	Endangered	
Yellow Sandshell	*Lampsilis teres*	Endangered	
Sheepnose	*Plethobasus cyphyus*	Endangered	
Spectaclecase	*Cumberlandia monodonta*	Endangered	
Purple Wartyback	*Cyclonaias tuberculata*	Threatened	
Ebonyshell	*Fusconaia ebena*	Endangered	
Black Sandshell	*Ligumia recta*	Threatened	
Grass Pickerel	*Esox americanus*	Threatened	Fish
Lake Sturgeon	*Acipenser fulvescens*	Endangered	
Western Sand Darter	*Ammocrypta clarum*	Endangered	
Longnose Sucker	*Catostomus catostomus*	Threatened	
Crystal Darter	*Crystallaria asprella*	Threatened	
Gravel Chub	*Erimystax x-punctatus*	Threatened	
Banded Killifish	*Fundulus diaphanus*	Threatened	
Pallid Shiner	*Hybopsis amnis*	Endangered	
Running Pine	*Lycopodium clavatum*	Endangered	
River Redhorse	*Moxostoma carinatum*	Threatened	
Pugnose Shiner	*Notropis anogenus*	Endangered	
American Eel	*Anguilla rostrata*	Threatened	
Indiana Bat	*Myotis sodalis*	Endangered	Mammal
Northern Long-eared Bat	*Myotis septentrionalis*	Threatened	
Southern Bog Lemming	*Synaptomys copperi*	Threatened	
Central Newt	*Notophthalmus viridescens*	Threatened	Amphibian
Four-toed Salamander	*Hemidactylium scutatum*	Threatened	
Mudpuppy	*Necturus maculosus*	Threatened	
Blanding's Turtle	*Emydoidea blandingii*	Endangered (IL)/ Threatened (IA)	Reptile
Eastern Massasauga Rattlesnake	*Sistrurus catenatus*	Endangered	
Ornate Box Turtle	*Terrapene ornata*	Threatened	
Barn Owl	*Tyto alba*	Endangered	Bird

Common Name	Scientific Name	Listing Status	Classification
Cerulean Warbler	*Dendroica cerulea*	Threatened	
Yellow-crowned Night Heron	*Nyctanassa violacea*	Endangered	
Black-crowned Night Heron	*Nycticorax nycticorax*	Endangered	
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Endangered	
Byssus Skipper	*Problema byssus*	Threatened	Insect
Schreber's Aster	*Aster schreberi*	Endangered	Plant
Downy Yellow Painted Cup	*Castilleja sessiliflora*	Endangered	
Sweet Indian Plantain	*Cacalia suaveolens*	Threatened	
Spotted Coral-root Orchid	*Corallorhiza maculata*	Endangered	
Mead's Milkweed	*Asclepias meadii*	Endangered	
Waxleaf Meadowrue	*Thalictrum revolutum*	Endangered	
Orange Grass St. John's Wart	*Hypericum gentianoides*	Endangered	
Slender Dayflower	*Commelina erecta*	Threatened	
Slender Ladies' tresses	*Spiranthes lacera*	Threatened	
Pink Turtlehead	*Chelone obliqua*	Endangered (IL)	

CONCLUSIONS AND RECOMMENDATIONS

The Steamboat Island HREP offers a unique opportunity to restore and enhance fish and wildlife resources within the lower section of the UMR Pool 14. The interagency coordination effort has demonstrated the value of this project towards maintaining a high quality UMR ecosystem while avoiding adverse impacts. The Steamboat Island HREP represents an opportunity to provide needed habitat restoration within Pool 14 of the UMR, through restoration of eroding islands, floodplain habitats, and degraded environmental conditions within the backwaters that will benefit migratory birds, fish, other wildlife, and plants. Additionally, the Steamboat Island HREP provides and maintains important linkages between similar habitats and refugia for migratory fish and wildlife species throughout Pool 14, including the Princeton Refuge HREP and Beaver Island HREP. Further, the Steamboat Island HREP meets the goals and objectives of the UMR NWFR, which was established by Congress in 1924 to provide a refuge and breeding ground for migratory birds, fish, other wildlife, and plants.

Therefore we recommend the preferred alternative which includes:

- Restoring topographic diversity in portions of the Project area by increasing existing elevations and planting trees, shrubs, understory plants, and buffer species, as well as implementing TSI measures, to address the Project objective of enhancing and restoring areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest.
- Increasing aquatic diversity in the Project area backwaters, specifically in Steamboat Island Upper Lake, Steamboat Island Lower Lake, and NW Grant Slough Lake, by excavation, which will address the Project objective of increasing year-round aquatic habitat. Where appropriate, additional fish and mussel habitat may be incorporated to

bring further benefit to the species that use the Project area. Due to the low cost and risk of these structures, further design will occur during the Plans & Specifications (P&S) stage. Preliminary design information for the fish and mussel habitat can be found in Appendix M, Engineering Design.

- Restoring and protecting island acreage on portions of Steamboat Island proper and the whole West SE Island by placing stone protection and dredged material, then planting with trees, to address the Project objective of restoring island acreage and protecting from erosion within the Project area.
- Placing protection measures at the NE Bank and the northwest end of the Cut-Through Channel of Steamboat Island and restoring SSP habitat in the Project area, to address the Project objective of protecting existing backwater habitat from sediment deposition and enhancing backwater and interior wetland areas.

Thank you for the opportunity to provide this ***draft*** Fish and Wildlife Coordination Act Report. If you have any questions, please contact Sara Schmuecker of my staff at [redacted]

Sincerely,

Kraig McPeek
Field Supervisor

Cc:

USFWS	Ed Britton, Nate Williams, Sharonne Baylor, Susan Cooper
IA DNR	Kirk Hansen
IL DNR	Rebekah Anderson, Matt O'Hara

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Appendix A

Endangered Species Act Section 7
Informal Consultation

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Illinois & Iowa ES Field Office
1511 47th Avenue
Moline, Illinois 61265
Phone: (309) 757-5800 Fax: (309) 757-5807

IN REPLY REFER TO:
FWS/ILIAFO
TAILS #03E18000-2020-I-0836

February 21, 2020

Jodi Creswell
Chief, Environmental Planning Branch
U.S. Army Corps of Engineers
Rock Island District
Attn: Davi Michl
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61201-2004

Dear Ms. Creswell:

This responds to your letter requesting concurrence from the Fish and Wildlife Service (Service) for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), dated January 22, 2020. The Steamboat Island HREP is part of the Upper Mississippi River Restoration (UMRR) Program and is located within Pool 14 of the Upper Mississippi River, extending along both sides of the navigation channel between river miles 502.5 and 508.0, Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. As part of the project, the U.S. Army Corps of Engineers, Rock Island District (District) has identified a tentatively selected plan (TSP) that incorporates refinements and conservation measures to minimize and avoid impacts to federally listed species, as your letter describes. You determined that the project may affect but is not likely to adversely affect (NLAA) the federally endangered Indiana bat (*Myotis sodalis*) and Higgins eye pearlymussel (*Lampsilis higginsii*), and the federally threatened northern long-eared bat (*Myotis septentrionalis*). This informal consultation addresses potential effects to the species in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*) and 50 CFR § 402 of our interagency regulations governing section 7 of the Act.

Multiple bat surveys have been conducted throughout the floodplain forests of Pool 14 in recent years. Specifically, a bat survey was completed in 2015 at the Beaver Island HREP, located approximately eight river miles upstream from the project area. The Beaver Island HREP survey identified both northern long-eared bats (acoustics and mist-netting) and Indiana bats (acoustics only). Additionally, a season-long acoustic survey conducted at the adjacent Princeton Wildlife Management Area identified use by both Indiana bats and northern long-eared bats in 2018; however, neither species was collected through mist-netting efforts. Due to the known presence of both the Indiana and northern long-eared bats within the project vicinity and the identification of potentially suitable habitat throughout the project area, we assume presence of these species throughout the project.

Project activities resulting in potential disturbance to Indiana and northern long-eared bat habitat include tree clearing to allow equipment access to the topographic diversity sites within the Grant Slough area and active timber stand improvement (TSI) practices. The TSP identifies approximately 1.3 acres of tree removal, which is roughly 0.07 percent of the total forested habitat available within the Steamboat Island complex. The tree removal, as proposed, will not result in fragmentation of bat roosting or foraging habitat and cleared areas will be replanted following the completion of construction. Recent tree inventories have identified potential roosting habitat throughout the remaining forested sections of the Steamboat Island complex, including trees that likely serve as primary or secondary roosts. Because the District proposes to complete this limited amount of tree clearing between October 1 and March 31, which is outside the bat active period, removal of unidentified maternity roost trees is unlikely to result in the incidental take of Indiana or northern long-eared bats. Further, the Service has identified certain incidental take of the northern long-eared bat resulting from tree removal as exempted from prohibition under the final 4(d) Rule of the Act (50 CFR 17).

TSI practices to be implemented across approximately 900 acres on Steamboat Island over the next ten years include thinning treatments, removal of non-desirable vegetation, and tree plantings. We anticipate thinning treatments, such as girdling, to benefit tree-roosting bats through the creation of increased snag habitat, canopy openings, and solar exposure. We further expect the removal of non-desirable vegetation within the understory to open up flight and foraging corridors to facilitate bat movement throughout the complex. The proposed tree plantings will consist of mast trees, including species which produce exfoliating bark, providing additional bat habitat as the trees mature. Additionally, proposed topographic diversity features include raising the ground elevation in areas currently dominated by low quality vegetation, such as the invasive reeds canary grass. Desirable tree species will be planted in these elevated areas, expanding upon existing forest habitat and increasing the quality, health, and resilience of the stand. Collectively, we expect these activities to result in positive, long-term benefits for potential roost tree production, foraging habitat, and habitat diversity. All tree thinning efforts will be completed outside of the bat maternity season, between October 1 and March 31, and any required herbicide treatments will be applied by a licensed applicator using state and federal standards, thus minimizing potential localized impacts.

For the reasons stated above, **we concur with your determination that the project may affect but is not likely to adversely affect** Indiana bats and northern long-eared bats.

Project features and activities resulting in disturbance to aquatic habitats include the mechanical dredging of dredge cuts for increased aquatic diversity sites and access channels. The TSP identifies approximately 510,692 cubic yards of proposed dredging. Additionally, the TSP proposes to restore acreage within the historic footprints at the head of Steamboat Island and the west southeast island that has been lost through erosion and inundation. Island footprint restoration and will include a combination of open water and bankline placement of dredged material and installation of approximately 504,380 cubic yards of stone protection to stabilize these sites and other areas of bankline erosion throughout the project area.

Freshwater mussel surveys were completed within the project area in 2018 and 2019. A combination of quantitative and qualitative sampling was conducted within most proposed project feature areas during the 2018 survey, with survey work confined to qualitative "spot" sampling within Grant Slough and the southeast islands. This effort identified six live Higgins eye pearlymussels between the Illinois bankline and the east southeast island. The east southeast island is located within the Cordova Higgins eye essential habitat area (EHA), spanning the Illinois bankline between approximate river miles 503-505.5. The District subsequently altered the project area boundaries to omit the east southeast island and areas within the EHA to minimize and avoid impacts to the Higgins eye pearlymussel.

A follow-up mussel survey was completed in 2019, to further assess the mussel resources within Grant Slough and surrounding the west southeast island. There were no federally listed mussel species identified as part of this effort. However, both survey efforts identified a species-rich assemblage of mussels within Grant Slough, with pockets of higher density areas. Together, these surveys will be used to inform the alignment of the access channel dredging within Grant Slough to avoid and minimize impacts to areas of higher mussel densities.

Further, the integration of rip rap, large woody debris, and a mixture of various sizes of river rock will provide suitable substrate and habitat features for freshwater mussel resources and their respective host fish. Collectively, we expect these features to increase the aquatic habitat structure and function within the project area.

For the reasons stated above, **we concur with your determination that the project may affect but is not likely to adversely affect** Higgins eye pearlymussels.

Two additional federally endangered mussel species are known to have ranges overlapping the project area, the sheepnose mussel (*Plethobasus cyphyus*) and the spectaclecase mussel (*Cumberlandia monodonta*). Historic surveys have found sheepnose within the Cordova EHA; however this species has not been identified in survey efforts since one fresh dead and one live individual were found in 2005 and 2006, respectively. Surveyors employed spectaclecase-specific survey methods where potentially suitable habitat was encountered during the 2018 and 2019 survey efforts within the project area; however, efforts resulted in the collection of no live specimens or shells.

The District made no effect determinations for the sheepnose mussel, spectaclecase mussel, eastern massasauga (*Sistrurus catenatus*), prairie bush clover (*Lespedeza leptostachya*), western prairie fringed orchid (*Platanthera praeclara*), eastern prairie fringed orchid (*Platanthera leucophaea*), and the Iowa Pleistocene snail (*Discus macclintocki*). The Illinois-Iowa Ecological Services Field Office has no regulatory or statutory authority for concurring with "no effect" determinations. However, we recommend you maintain a written record of your "no effect" determination and include it in your decision record. An example "no effect" memo can be found on our website at http://www.fws.gov/midwest/endangered/section7/s7process/letters.html.

Finally, the Service removed bald eagles from protection under the Act on August 8, 2007. However, they remain protected today under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (Eagle Act). The Eagle Act prohibits take which is defined as, "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb" (50 CFR 22.3). We define disturb in regulations as, "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." An eagle nest has been known to exist within the project boundaries, at the head of Steamboat Island; however, it is suspected that the nest may have fallen as a result of flood impacts in 2019. The status of this nest should be confirmed prior to the onset of construction activities. Should potential disturbance to eagles or eagle nests be identified, consultation should be initiated.

This letter provides comments under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and the Endangered Species Act of 1973, as amended. Should you modify the project or if new information indicates endangered species may be affected, consultation should be initiated. Thank you for the opportunity to provide comments. If you have any additional questions or concerns, please contact please contact Sara Schmuecker of my staff at [redacted]

Sincerely,

Kraig McPeek
Field Supervisor

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APPENDIX B

Habitat Evaluation and Benefits Quantification Results

Tables extracted from Appendix D of the ***draft*** Upper Mississippi River Restoration Feasibility Report with Integrated Environmental Assessment, Steamboat Island HREP (USACE 2020)

Table D-3: Aquatic Benefit Evaluation Results for Backwater Excavation Measures

				OUTPUT					
Measure	**Measure Name**	**Condition**	**Target Year**	**Bluegill SI**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Overwinter Fish Habitat	No Action-Steamboat Island Proper Complex	Existing	0	0.52	0.52	0.14	1.0	0.10	**0.0**
		FWOP	10	0.52	0.52	0	0.0		
			25	0.52	0.52	0	0.0		
			50	0.52	0.52	0	0.0		
	Steamboat Island Proper Complex	With Project	1	0.94	0.94	23	22.0	19.19	**19.1**
			10	0.87	0.87	23	21.0		
			20	0.87	0.87	23	21.0		
			30	0.87	0.87	21	19.0		
			50	0.77	0.77	19	15.0		
	No Action- Grant Slough Complex	Existing	0	0.52	0.52	0	0.0	0.00	**0.0**
		FWOP	10	0.52	0.52	0	0.0		
			25	0.52	0.52	0	0.0		
			50	0.52	0.52	0	0.0		
	Grant Slough Complex	With Project	1	0.94	0.94	6	6.0	5.94	**5.9**
			10	0.87	0.87	6	6.0		
			20	0.87	0.87	6	6.0		
			30	0.87	0.87	6	6.0		
			50	0.77	0.77	6	5.0		

Table D-4: Mussel Habitat Benefit Evaluation Results for Flow Diversity/Island Restoration Measures

				OUTPUT					
Measure	**Measure Name**	**Condition**	**Target Year**	**Walleye SI**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Mussel Habitat	No Action	Existing	0	0.30	0.30	0.4	0.1	0.10	**0.0**
		FWOP	10	0.25	0.25	0.4	0.1		
			25	0.20	0.20	0.4	0.1		
			50	0.15	0.15	0.4	0.1		
	Steamboat Slough Flow Diversity	With Project	1	0.72	0.72	0.4	0.3	0.20	**0.1**
			10	0.74	0.74	0.4	0.3		
			25	0.75	0.75	0.4	0.3		
			50	0.74	0.74	0.4	0.3		
	No Action	Existing	0	0.74	0.74	0	0.0	0.00	**0.0**
		FWOP	10	0.72	0.72	0	0.0		
			25	0.70	0.70	0	0.0		
			50	0.65	0.65	0	0.0		
	West SE Island	With Project	1	0.31	0.31	1	0.3	0.64	**0.6**
			10	0.71	0.71	1	0.7		
			25	0.70	0.70	1	0.7		
			50	0.74	0.74	1	0.7		

Table D-5: Floodplain Benefit Evaluation Results for Topographic Diversity Measures

				OUTPUT						
Measure	**Measure Name**	**Condition**	**Target Year**	**Gray Squirrel SI**	**Yellow Warbler SI**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Floodplain Forest/ Scrub-Shrub Wetlands	No Action-USI Head	Existing	0	0.00	0.00	0.00	14	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	14	0.0		
			30	0.00	0.00	0.00	14	0.0		
			50	0.00	0.00	0.00	14	0.0		
	USI Head	With Project	1	0.00	0.00	0.00	14	0.0	10.30	**10.30**
			20	0.00	1.00	1.00	14	14.0		
			30	0.91	0.00	0.91	14	12.7		
			50	0.91	0.00	0.91	14	12.7		
	No Action-Steamboat Island Proper Complex	Existing	0	0.00	0.00	0.00	14	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	14	0.0		
			30	0.00	0.00	0.00	14	0.0		
			50	0.00	0.00	0.00	14	0.0		
	Steamboat Island Proper Complex	With Project	1	0.00	0.00	0.00	14	0.0	10.30	**10.30**
			20	0.00	1.00	1.00	14	14.0		
			30	0.91	0.00	0.91	14	12.7		
			50	0.91	0.00	0.91	14	12.7		
	No Action-Grant Slough Complex	Existing	0	0.00	0.00	0.00	30	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	30	0.0		
			30	0.00	0.00	0.00	30	0.0		
			50	0.00	0.00	0.00	30	0.0		
	Grant Slough Complex	With Project	1	0.00	0.00	0.00	30	0.0	22.00	**22.00**
			20	0.00	1.00	1.00	30	30.0		
			30	0.91	0.00	0.91	30	27.2		
			50	0.91	0.00	0.91	30	27.2		
	No Action-West SE Island	Existing	0	0.00	0.00	0.00	4	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	4	0.0		
			30	0.00	0.00	0.00	4	0.0		
			50	0.00	0.00	0.00	4	0.0		

Table D-5: Floodplain Benefit Evaluation Results for Topographic Diversity Measures (continued)

				OUTPUT						
Measure	**Measure Name**	**Condition**	**Target Year**	**Gray Squirrel SI**	**Yellow Warbler SI**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Floodplain Forest/ Scrub-Shrub Wetlands	West SE Island	With Project	1	0.00	0.00	0.00	4	0.0	2.90	**2.90**
			20	0.00	1.00	1.00	4	4.0		
			30	0.91	0.00	0.91	4	3.6		
			50	0.91	0.00	0.91	4	3.6		
	No Action-Steamboat Island Proper Complex Scrub-Shrub	Existing	0	[redacted]	0.00	0.00	5	0.0	0.00	**0.00**
		FWOP	20	[redacted]	0.00	0.00	5	0.0		
			30	[redacted]	0.00	0.00	5	0.0		
			50	[redacted]	0.00	0.00	5	0.0		
	Steamboat Island Proper Complex Scrub-Shrub	With Project	1	[redacted]	0.00	0.00	5	0.0	3.90	**3.90**
			20	[redacted]	1.00	1.00	5	5.0		
			30	[redacted]	1.00	1.00	5	5.0		
			50	[redacted]	1.00	1.00	5	5.0		

Table D-6: Floodplain Benefit Evaluation Results for Timber Stand Improvement Measures

Measure	Measure Name	Condition	Target Year	HGM FCI	FCI Final	Acres	HUs	AAHUs	Net AAHUs
Timber Stand Improvement	No Action-TSI	Existing	0	0.64	0.64	900	576.0	461.00	**0.00**
		FWOP	50	0.51	0.51	900	459.0		
	TSI Prescriptions	With Project	1	0.64	0.64	900	576.0	779.00	**318.0**
			50	0.87	0.87	900	783.0		

APPENDIX C
Assumptions

Text extracted from Appendix D of the ***draft*** Upper Mississippi River Restoration Feasibility Report with Integrated Environmental Assessment, Steamboat Island HREP (USACE 2020)

A. Quantity Component. Traditionally, the Corps has used the quantity and quality of habitat jointly, in the form of habitat units (HUs), to measure benefits provided by ecosystem restoration projects. The quantity portion is often measured as area (acres of habitat, landform, etc.) or number of species; in some systems, it is measured as length (miles of stream bank). The evaluation conducted for the Project uses acres, delineated by polygons, to represent the quantity. The area associated with each management measure must have a clear definition for use as guidance in estimating the area component of the ecosystem output model, and must be applied consistently to all actions evaluated. From the qualitative and quantitative determinations, the standard unit of measure, HU, is calculated using the formula (HSI x Acres = HUs) for all selected HSI models.

With or without a project, habitat conditions change over time; therefore, the overall value of a proposed project depends upon the comparison of expected with-project benefits to expected without-project benefits. Annualized HUs are referred to as average annual habitat units (AAHUs). To assess the change over the period of analysis, the PDT identified target years (TYs) where a change in the habitat variables may be noticed. Noticeable changes are characterized by a change in habitat benefit output. Model TYs by species:

- Bluegill TY: 0, 1, 10, 20, 30, 50
- Walleye TY: 0, 1, 10, 25, 50
- Yellow warbler TY: 0, 1, 20, 30, 50
- Gray squirrel TY: 0, 1, 20, 30, 50

For this Project, the area of the action footprint (physical footprint of management measures) was selected to measure and compare the habitat benefits of each alternative (Table D-1). When multiple management measures are included in an action, the footprint equals the total of the management-measure footprints with no double counting of overlapping areas addressed by two or more management measures. Acreage differs for Future With and Without Project due to the trade-off between unlimiting habitat (ex: wetland) for limiting habitat (ex: aquatic).

There are trade-offs associated with restricting the evaluation of benefits to the action footprint. On the one hand, benefits can be accurately quantified with a high degree of certainty and allow for the development of specific and measurable criteria to be used in monitoring Project performance; however, the action footprint also tends to grossly underestimate the areal extent of ecological benefits because the area of restored biotic/abiotic processes usually covers a much broader scale.

Although the habitat evaluation of the Project was limited to the action footprint, it should be recognized that benefits of various measures likely extend beyond this immediate footprint as biotic and abiotic processes are restored. However, estimating habitat benefits at higher scales (e.g., area of restored process, area of potential influence) was considered too uncertain or speculative to accurately assess.

Table D-1: Habitat Types and Areas Evaluated for this Assessment

Habitat Type	Evaluation Area	Area (acres)	HSI Model
Aquatic	Steamboat Island (Upper and Lower Lakes) – Aquatic Diversity	23	Bluegill
	NW Grant Slough – Aquatic Diversity	6	Bluegill
	Steamboat Slough – Flow Diversity	0.4	Walleye
	West SE Island – Mussel Habitat	1	Walleye
Floodplain[1]	Steamboat Island – Forest Topographic Diversity	14	Yellow Warbler/Gray squirrel
	Steamboat Island – Scrub-Shrub/Pollinator Topographic Diversity (Lower Lake)	5	Yellow Warbler
	USI Head – Forest Topographic Diversity	14	Yellow Warbler/Gray
	Grant Slough Complex – Forest Topographic Diversity (4 sites)	30	Yellow Warbler/Gray squirrel
	West SE Island – Forest Topographic	4	Yellow Warbler/Gray
TOTAL		97.4	

[1] TSI measures were not included in the initial habitat analysis, but they were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project Area. See Sections III.C.3 and IV for methods and results of the Hydrogeomorphic (HGM) Approach that was later applied to support the TSP.

B. Quality of Aquatic Benefits. The methodology utilized for evaluating benefits to aquatic habitat incorporates the HEP format, which was developed by the USFWS. HEP is a habitat-based evaluation methodology used in project planning. The procedure documents the quality and quantity of available habitat for selected fish and wildlife species. HEP is based on the assumption that habitat for selected fish and wildlife species can be described by a HSI. This index value (on a scale from 0.0 to 1.0) is multiplied by the area of applicable habitat to obtain HUs, which are used in comparisons of the relative value of fish and wildlife habitat at points in time.

Changes in HUs will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the life of the Project (50 years). HUs are calculated for select target years and annualized (using IWR Planning Suite NER Annualizer) over the life of the Project to derive AAHUs. AAHUs are used as the output measurement to compare the measures and alternatives for the proposed Project.

1. Backwater Habitat. The Corps-approved (per EC 1105-2-412) Bluegill HSI model (Stuber et al. 1982a; Palesh and Anderson 1990) was used to assess the backwater habitat benefits resulting from the aquatic diversity measures at Upper Lake, Lower Lake, and NW Grant Slough. These species were selected because they require backwater habitat for all or most of their life cycle and are often limited in the availability of high quality overwintering habitat. The following assumptions in applying the Bluegill HSI model were made:

Baseline Condition. Detailed water quality data was collected from 2014 to present at monitoring stations in the backwater area. Due to the length of the data collection and location, it was assumed the data collected at each station was representative of the entire backwater. For the purposes of model input, the spawning season was May to June, growing season June to September, and overwintering December to February. It was assumed the water quality entering Steamboat Island interior was similar to Steamboat Slough and the main channel.

Future Without Project Conditions. Future conditions of all backwater lakes were based on an average sediment deposition rate of 1 cm/year over the next 50 years. This rate was determined based on information obtained from IADNR sedimentation studies (Aspelmeier, 1994). It is not likely that aquatic habitat loss would be linear, as most sedimentation occurs during flooding events. Nonetheless, over time aquatic habitat will be reduced significantly. Remaining lentic habitat will consist of isolated interior shallow pools with fish access only during high water events or small (< 0.14 acre) limited overwintering areas. It is probable that the Project area will continue to provide spawning habitat based on future floodplain conditions. Rearing and foraging habitat currently provided by the interior backwaters will be substantially reduced as remaining pool habitat will have impaired water quality or restricted access during average flows. Consequently, summer habitat will shift to another backwater complex or to other flowing channels, if available, in Pool 14. Finally, overwintering habitat will continue to be limited to near zero within the interior backwaters of the Project.

Future With Project Conditions. The proposed final depth of each backwater lake is 8 feet. With approximately 1.6 feet of sediment accumulating over 50 years, adequate depths would still be present for overwintering habitat. Therefore, it was assumed percent backwater greater than 4 feet in depth would increase to near 80% with a slight decrease over time due to sediment deposition on the slopes of the excavation site.

2. Riverine Habitat. The Corps-approved (per EC 1105-2-412) Walleye HSI model (McMahon et al. 1984) was used to assess the riverine habitat benefits resulting from West SE Island protection via riprap bank stabilization. Walleye was selected primarily because it is a popular host fish species for numerous freshwater mussels that inhabit the Project area. Walleye is rheophilic (or oriented to flow) and captures the benefits from an increase in forage, water clarity, and spawning habitat afforded by the restoration measures; therefore, the increasing of suitable fish hosts was assumed to have potential benefits to the freshwater mussel community. The following assumptions in applying the Walleye HSI models were made:
Baseline Condition. Water quality and hydraulic data from the main channel was assumed to be similar to the West SE Island. For the purposes of model input, the spawning season for walleye was March to May and growing season June to October. The 2019 mussel survey confirmed the absence of ideal mussel habitat as substrates were dominated by shifting sand and no mussels were recovered during the quantitative portion of the survey.

Future Without Project Conditions. It was assumed West SE Island would continue to experience erosion at a rate of 0.14 acres per year (see Appendix M, *Engineering Design* for more details on erosion rates). At its current estimated size of 0.36 acres, the island will have completely eroded within the span of a few years. Consequently, available habitat structure and cover, food production, and potential spawning habitat for walleye and mussels would be reduced.

Future With Project Conditions. Restoration and protection of the island would reduce erosion and potentially initiate island growth through reduced year-round velocities and aggradation of sediments. Rock would increase habitat structure for fish cover and because preferred mussel habitat is currently absent, no mussel impacts were assessed for the model. Due to the increase in habitat availability and complexity, cover and forage fish abundance is expected to increase. The stone protection area around the island was multiplied by a factor of 2 to create a "shadow effect" of preferred mussel habitat, amounting to approximately 1 acre. A very important element is the continued structure and function of the island and its potential indirect benefit as a buffer to the Cordova EHA. This continues to provide the functional attributes necessary for the freshwater mussel community to continue to exist, reproduce, and recruit to the population.

C. Quality of Floodplain Benefits. HEC-EFM was used to derive preliminary acreages for floodplain forest and scrub-shrub/pollinator benefits (Section V, *Development and Evaluation of Alternatives*). Threshold elevations to model aquatic, scrub-shrub, and forestry acres for the Project area were developed based on growing season inundation duration and exceedance probability determined by the PDT's best professional judgment (see Appendix M, *Engineering Design*). Time series analyses to identify the appropriate elevation threshold for each habitat type was performed using HEC-EFM. Acreages for each habitat type were then calculated based on existing conditions and with-Project terrains and elevation thresholds. Then, both the Corps-approved (per EC 1105-2-412) Yellow Warbler (Schroeder, 1982) and the Gray Squirrel (Allen, 1987) HSI models were employed to quantify the habitat benefits associated with increases in topographic diversity and bottomland forest restoration during both initial succession and forest maturation.

1. Forestry Habitat. Alternative restoration states include the area and height of topographic diversity. Topographic diversity is important because different plant communities occur within specific flood zones, and lack of physical diversity can lead to low plant community diversity, which has been seen in large rivers nation-wide. The upper limit of tree planting was identified as 576.2 feet NAVD88, which is based on the 25-percent exceedance probability for the minimally tolerant growing season inundation criteria (25-day inundation duration) and the lower limit of tree planting was identified based on the 25-percent exceedance probability for the moderately tolerant growing season inundation criteria (45-day inundation duration).

The Yellow Warbler HSI Model was used to assess pioneer floodplain forest habitat because yellow warblers prefer hydrophytic scrub-shrub habitat for foraging and nesting and are often limited in the availability of quality wet scrub-shrub habitat. For measures that only involve the planting of forestry habitat, the Yellow Warbler model was only modeled at TY 20 to represent the benefits accrued during initial succession of the floodplain forest. The following assumptions in applying the Yellow Warbler HSI model were made:

Baseline Condition. There is currently very few hard mast tree species available in the Project area. Areas that have the required elevation to support this habitat are either dominated by reed canary grass monocultures or have been eroded by increasing flood frequency and duration and higher water tables. A lack of tree regeneration, species diversity, and increased mortality characterizes the floodplain forest in the Project area.

Future Without Project Conditions. It is assumed that tree mortality and tree recruitment will continue at a rate similar to the last 30 years. Open canopy areas will continue to be degraded and likely result in reed canary grass monoculture development, especially in areas already dominated by this invasive species. For areas that currently have existing forestry habitat, it was assumed that increasing water inundation and duration and island erosion will result in a continued loss of topographic diversity.

Future With Project Conditions. Placement at these sites requires very little tree clearing (1.3 acres) and results in a significant increase in habitat benefits as areas currently dominated by reed canary grass monocultures are converted floodplain forest habitat with inclusion of hard mast tree species. Restoring island areas to optimum tree survival elevations also provides an increased buffer to backwater lakes, helping to slow down water during high flows and allow sediment to drop out prior to reaching potential overwintering habitat. TSI efforts (tree thinning treatments, tree planting, and invasive species management) would continue for the life of the Project (50 years) to further improve habitat health, diversity, and resilience of forestry sites.

The Gray Squirrel HSI Model was used to assess hard mast tree habitat because grey squirrels require diverse mast producing tree habitat for forage, cover, and reproduction, and are often limited in the availability of mast producing trees in the floodplain. The Gray Squirrel HSI was only modeled at TYs 30 and 50 to represent the amount of time it would take for tree plantings to mature and begin accruing habitat benefits. In applying the Gray Squirrel HSI model, the same assumptions were made as the Yellow Warbler HSI Model.

2. Scrub-Shrub/Pollinator Habitat. The Yellow Warbler HSI Model was used to assess pioneer floodplain forest habitat because yellow warblers prefer hydrophytic scrub-shrub habitat for foraging and nesting and are often limited in the availability of quality wet scrub-shrub habitat. For measures that only involve the planting of scrub-shrub/pollinator habitat, the yellow warbler model was used for all TYs to evaluate habitat benefits.

The upper limit for scrub-shrub/pollinator planting was identified as 573.1 feet NAVD88; this elevation is based on the 50-percent exceedance probability for maximum tolerant growing season inundation duration (55-day inundation duration). However, field observations by the Project forester support that scrub-shrub/pollinator species can thrive at higher elevations than the upper limit, so these plantings may be incorporated at higher elevations. The following assumptions in applying the Yellow Warbler HSI model were made:

Baseline Condition. There is currently very little scrub-shrub/pollinator habitat available in the Project area. Areas that have the required elevation to support this habitat are either dominated by reed canary grass monocultures or open water areas adjacent to existing scrub-shrub/pollinator habitat.

Future Without Project Conditions. Open canopy areas will continue to be degraded and likely result in reed canary grass monoculture development, especially in areas already dominated by this invasive species. For areas adjacent to existing shrub-shrub/pollinator habitat, it was assumed that sediment deposition and increasing water inundation and duration will result in a continued loss of topographic diversity.

Future With Project Conditions. Placement at these sites requires no tree clearing and removal and provides significant habitat benefits as reed canary monocultures are converted to scrub-shrub/pollinator habitat. Planting at sites near existing scrub-shrub/pollinator habitat will help to protect the existing habitat, while increasing and enhancing the habitat in that area. TSI efforts (buttonbush coppicing) would continue for the life of the Project (50 years) to further enhance the topographic diversity of scrub-shrub/pollinator habitat sites.

3. TSI Benefits Using HGM Approach. TSI measures were not included in the initial habitat analysis, but were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project area. Since TSI prescriptions were anticipated to be the same for all Final Array Project alternatives, the Hydrogeomorphic (HGM) Approach was later applied to support the TSP and demonstrate the additional benefits provided by TSI actions relative to the cost of the Project. The HGM Approach is a collection of concepts and methods for developing functional indices and using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. This approach to functional assessment estimates the change in functioning induced by alteration of a wetland, either positive or negative. Though initially designed to be used in the context of the Clean Water Act Section 404 permit reviews, the HGM Approach can also be used to determine the amount of positive effects (i.e., increases in sustainable levels of functioning) normally through restoration of previously altered wetlands of the same type. For this assessment, the PDT used the Corps-certified HGM Approach for Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley (Klimas et al., 2004), a regional guidebook which provides the models and reference data used to assess the functional capacity of the floodplain forest to:

- Detain floodwater,
- Detain precipitation,
- Cycle nutrients,
- Export organic carbon,
- Maintain plant communities, and
- Provide habitat for fish and wildlife.

Similar to the HEP format, the PDT used the HGM approach and assessment models to evaluate habitat benefits resulting from TSI implementation, which are described as Functional Capacity Index (FCI) values (on a scale from 0.0 – 1.0). The FCI values for all functions were averaged and multiplied by area to derive net benefits (AAHUs) between the Future Without and Future With Project conditions at TY 50. The following assumptions in applying the Delta Region HGM guidebook to the Project area were made:

Baseline Condition. A lack of tree regeneration, species diversity, and increased mortality characterizes the floodplain forest in the Project area. The forest is currently dominated by over-mature even-aged silver maple stands, with limited regeneration and decreasing numbers of hard mast-producing trees. TSI prescriptions were derived from current environmental and forest conditions and focused on areas at higher risk of forest decline (approximately 900 acres).

Future Without Project Conditions. It is assumed that tree mortality and tree recruitment will continue at a rate similar to the last 30 years. Future average flood frequency and duration were also assumed to remain constant over the Project life (50 years). Without TSI implementation and successive tree recruitment, open canopy areas will continue to be degraded and likely result in reed canarygrass monoculture development. This slow progression over several decades will further increase the probability of conversion from closed-canopy forest communities to expansive acres of non-native herbaceous species. Thus, as mortality of even-aged silver maple stands increases, tree basal area (BA) and density are assumed to decrease by half from the baseline condition. These forecasted conditions for the FWOP were based on Corps' forester best professional judgment, reflecting reference stand conditions of the UMR that can reasonably be expected to occur without implementation of TSI in the Project area.

Future With Project Conditions. It is assumed that implementation of TSI will alter the long-term impacts of an overstocked forest, improving forest habitat health, diversity, and resilience in the Project area. TSI actions (tree thinning treatments, tree planting, and invasive species management) will continue for the life of the Project (50 years), gradually opening the forest canopy, providing light to understory seedlings and saplings and interspersed tree plantings, enabling recruitment of various tree ages, and reducing undesirable vegetation and competition for native species. In the short term, these alterations will help uniformly distribute needed growing space and sunlight throughout TSI areas during a single treatment window of just under 2 years, thereby reducing the risk of forest conversion to non-native species by creating favorable conditions to young tree establishment. After 50 years, the amount of growing space (BA) will increase from the baseline condition, while tree density will even out over the Project life. These forecasted conditions for the FWP were based on Corps' forester best professional judgment, reflecting reference stand conditions of the UMR that can reasonably be expected to occur following implementation of TSI in the Project area.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Upper Mississippi River National Wildlife and Fish Refuge
102 Walnut Street, Suite 204
Winona, Minnesota 55987

April 8, 2020

Julie Millhollin
Project Manager
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, PO Box 2004
Rock Island, IL 61204-2004

Julie
Dear Ms. Millhollin:

The Upper Mississippi River National Wildlife and Fish Refuge (Refuge) has reviewed the draft Feasibility Report and Tentatively Selected Plan for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) and provides the following statements in support of the project.

This project meets the goals and objectives of the Refuge. The Refuge was established by Congress in 1924 to provide a refuge and breeding ground for migratory birds, fish, other wildlife, and plants. There have been many changes in environmental conditions on the Upper Mississippi River since the Refuge was established that have resulted in substantial ecosystem degradation. Steamboat Island represents a key location found in Pool 14 to restore degraded environmental conditions within the backwater and floodplain forest habitats that will benefit migratory birds, fish, other wildlife, and plants.

The Steamboat Island HREP will benefit a large area of Pool 14. This is especially important because Pool 14 begins the transition of the Upper Mississippi River ecosystem, and Steamboat Island is a key element of environmental integrity before the transition. As you proceed downriver from Steamboat Island, the river abruptly changes to a narrow channel with relatively fast flowing current. Downriver shoreline areas are in private and commercial ownership with high demand for residential, industrial and community development.

The existence of numerous backwater lakes and extensive flowing side channels within and around Steamboat Island provides an excellent opportunity to restore favorable habitats for fish and wildlife within this forested floodplain ecosystem. Steamboat Island, Grant Slough and the adjacent Wapsipinicon River bottoms make up a large footprint on the Upper Mississippi River, and its extensive acreage of both land and water provides a unique opportunity to restore a relatively large ecosystem in a section of river that is greatly degraded.

The project will increase aquatic diversity and provide important environmental benefits for many species of fish and wildlife. The deepening of backwater lakes will improve water quality, increase oxygen content, and provide optimum habitat for a variety of aquatic species. It will also provide year-round fish habitat, but more importantly will restore overwintering habitat that is currently nearly non-existent within the Steamboat Island complex and adjacent project areas in Pool 14. The dredged material from the aquatic areas will be used beneficially to increase island elevations.

Increasing island elevations will complement the areas of existing floodplain forest, while minimizing impacts to threatened, endangered, and protected species. Currently, most of the amphibians and reptiles that inhabit Steamboat Island are flooded out during annually re-occurring high water events. High water events that cover the island are occurring more often and for longer periods, often extending throughout the summer. The proposed elevated island areas will provide a land sanctuary and allow for the seasonal survival of many species of reptiles and amphibians.

Improving forest diversity and quality is an important part of this HREP project. Throughout the project footprint a mixture of forest quality can be found, with higher elevations having a greater species diversity and overall forest health. However, lower elevations suffer in both diversity and health and have been subject to longer inundation periods over the last decade. Raising the elevation by a few feet will allow the planting of floodplain tolerant hardwood trees and provide additional forest habitat acres. In addition, wetland shrubs are to be inter-planted within the trees. Timber stand improvement to include selective tree harvest, crop tree release and girdling will occur in other low diversity forest areas where excavated material will not be placed. The increased tree diversity will provide additional long-term benefits to migratory birds and federally-listed bat species, furthering the mission of the USFWS.

The placement of a grade control structure within the Steamboat Island's cut-through channel, in an effort to deflect sediment and reduce silt laden flows from entering the lower lakes of Steamboat Island, will provide optimum protection for the longevity of the Steamboat Island HREP project. Water flows entering the lower lakes are the primary source of sedimentation from the nearby confluence of the Wapsipinicon River. A river training structure to eliminate this primary source of silt is a critical component of the project. Additional protection along the NE bank line will also ensure that existing and restored habitat throughout the upper lakes will be self-sustaining.

The project includes bank line protection for the island head and the NE bank of Steamboat Island. It also includes the restoration of a small island adjacent to the main island. The small SE island has been subject to extensive erosion and has lost the majority of its historical footprint. Restoration of the island will provide flow diversity within the area and has the potential to support habitat for the Federally Endangered Higgins eye pearly mussel. Restoration of the island head and NE bank line provide an essential barrier that will protect Steamboat Island from wind and wave action, especially from passing towboats and recreational boaters. Erosion at the head of Steamboat Island and along its east shoreline is substantial. Stabilization of the island will prevent future shoreline erosion and will provide long term protection to Steamboat Island and its interior habitat.

In summary, the Refuge supports the Steamboat Island HREP project and considers it to be another important habitat restoration and enhancement project that can be completed in Pool 14. The island's large size, extensive forestry component, numerous backwater lakes, and flowing side channels make it a vital HREP project.

We appreciate our continued partnership with the Corps and state agencies on the Steamboat Island project and the Upper Mississippi River Restoration program. Should you have questions regarding this letter, please contact Mr. Ed Britton, Savanna District Manager, at [redacted] or Ms. Sharonne Baylor, Environmental Engineer, at [redacted]

Sincerely,

Sabrina Chandler

Sabrina Chandler
Refuge Manager

cc: Ed Britton, Upper Mississippi River NW&FR
Nate Williams, Upper Mississippi River NW&FR
Kraig McPeek, Illinois-Iowa Field Office
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Sharonne Baylor, Upper Mississippi River NW&FR
Kirk Hansen, Iowa Department of Natural Resources

Julie Millhollin
Project Manager
U. S. Army Corps of Engineers
Rock Island District
Clock Tower BLDG. PO Box 2004
Rock Island IL 61204-2004

April 9, 2020

Dear Mrs. Millhollin:

This will serve as the letter of support from the Iowa Department of Natural Resources (DNR) for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) under the Upper Mississippi River Restoration (UMRR) program. The Iowa DNR fully concurs with the draft feasibility report and the Tentatively Selected Plan (TSP). My staff has been intricately involved with the planning of this critical HREP. The TSP is expensive but provides the critical habitat needed to accomplish the goals of the project. The Steamboat Island Project includes measures to improve bottomland hardwood forest coverage and diversity, increase acreage of backwater overwintering habitat, restore lost island acreage and protect them from future erosion, reduce sedimentation in off-channel backwaters and wetlands, and restore scrub-shrub/pollinator habitat within Steamboat Island, Grant Slough, and the Wapsipinicon River Delta in Pool 14.

The forest community of the Upper Mississippi River (UMR) changed considerably following water level increases caused by impoundment of the river for the 9-foot navigation project in the 1930's. Currently, the islands of the UMR are dominated by Silver Maple and Cottonwood. These soft mast trees are important to the islands of the Mississippi because they provide nesting sites for many species of birds, including bald eagles, colony nesting birds, cavity nesting birds and migratory neo-tropical passerines. These soft mast trees have colonized many of the islands on the Mississippi River, but are not long lived. Most stands are relatively even aged and near the end of their life span, and there has been little regeneration on these low areas on the River. This HREP will provide large areas for a diversity of bottomland hardwood forest and scrub-shrub/pollinator species, which directly benefit migratory and resident wildlife species. Providing higher areas to enhance forest diversity, along with proposed Timber Stand Improvement prescriptions, will encourage and promote a sustainable, healthy and resilient forest for many years to come.

Off-channel, overwintering habitat is critical to maintaining the health and resiliency of the fisheries community of the UMR. Over time, the quantity and quality of this habitat has declined due to sedimentation and island dissection. This HREP will restore this critically important habitat within Steamboat Island where it has been all but lost. Additionally, protection of the NE bank of Steamboat Island and the grade control structure in the cut-through channel are critical for reducing sediment delivery and ensuring project longevity.

Islands are critical for maintaining the mosaic of diverse habitats within the UMR. Steamboat Island and the SE Islands near Cordova have lost over 150 acres to erosion since construction of Lock and Dam 14. Erosion and dissection of islands cause degradation of interior wetlands and backwaters by accelerating sedimentation and increasing velocities. This HREP will restore island acreage to preserve and enhance the structure and function of Steamboat and the West Southeast Island.

The Iowa DNR is very supportive and proud to be a non-federal partner of the Steamboat Island HREP. We look forward to the timely completion of this environmental restoration project. We are fully committed to the partnership developed under UMRR and pledge to help with project execution and evaluation. Fish and wildlife along the Mississippi River will benefit immensely from this project.

Sincerely,

Kayla Lyon

Kayla Lyon
Director, Iowa Department of Natural Resources

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX B

CLEAN WATER ACT SECTION 404(b)(1) ASSESSMENT:
NATIONWIDE PERMIT 27 JUSTIFICATION

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

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APPENDIX B

CLEAN WATER ACT SECTION 404(b)(1) ASSESSMENT: NATIONWIDE PERMIT 27 JUSTIFICATION

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FIGURE

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX B

CLEAN WATER ACT SECTION 404(b)(1) ASSESSMENT: NATIONWIDE PERMIT 27 JUSTIFICATION

I. CLEAN WATER ACT COMPLIANCE INTRODUCTION

The District and the USFWS are required to comply with Clean Water Act (CWA) Sections 401 and 404 for the *Steamboat Island Habitat Rehabilitation and Enhancement Project* (Project). This appendix details the District and USFWS justifications why this Project meets the conditions and requirements of CWA Nationwide Permit (NWP) 27 – Aquatic Habitat Restoration, Establishment, and Enhancement Activities.

Within its current regulatory program, the Corps has authority over work on structures in navigable waterways under Section 10 of the Rivers and Harbors Act of 1899 and over the discharge of dredged or fill material under Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). This latter requirement applies to wetlands and other valuable aquatic areas throughout the United States.

This assessment, in conjunction with the Environmental Assessment, will assist in analysis of the alternatives for this Project, resulting in the Tentatively Selected Plan (TSP). Furthermore, this evaluation will provide information and data to the States of Iowa and Illinois water quality certifying agencies demonstrating compliance with State water quality standards, informing the decision making process concerning State 401 water quality certification.

II. THE PERMITTING PROCESS

The Corps requires permits for building or developing in, on, or over wetlands and waters of the United States. The Corps regulatory program permit evaluation process results in permit decisions balancing the need for proposed development with protection of the nation's aquatic environment. The level of the Corps evaluation is commensurate with the level of the environmental impacts and the aquatic functions and values involved in the particular area being impacted. Authorization can range from programmatic permits to Individual Permit review. Impacts to higher ecological value areas would be subject to a much more detailed evaluation and a strong focus on avoidance and minimization of impacts to the aquatic environment. In the case of this Project, the planning team's CWA compliance procedures include:

- consulting with the local Corps regulatory office, which is located at the District headquarters office in Rock Island, Illinois. This consultation determined that the Project preliminarily complies with NWP 27 and would not require an Individual 404 Permit.

- demonstrating why NWP 27 would be the appropriate level of compliance. This appendix outlines the information the District's regulatory office reviewed to make their final concurrence/non- concurrence determination.

- having the District's Regulatory Branch provide a written statement of concurrence/non-concurrence, the information herein satisfies the use of NWP 27 (see Appendix A, *Correspondence).*

III. PROJECT DESCRIPTION

A. Location. The Project is located in the middle section of Pool 14 of the Upper Mississippi River in Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. The Project area is between river miles (RM) 502.5 and 508.0, adjacent to the Cities of Princeton, Iowa, and Cordova, Illinois.

B. General Description. The District proposes to rehabilitate and enhance the Project through construction of measures that will increase the quality of year-round habitat for the fish community, increase floodplain forest vegetation diversity, and improve the overall structure and function of the Project. The purpose of this feasibility report is to present a detailed account of the planning, engineering, and construction details of the TSP to allow final design and construction to proceed subsequent to approval of this document.

C. Project Measures. The District performed a thorough plan formulation process to identify potential management measures and restoration actions addressing the Project objectives. Many alternatives, which are a combination of one or more measures, were considered, evaluated, and screened in producing a final array of alternatives. The District subsequently identified a TSP (Figure B-1). Sections IV, V, and VI of the Main Report details the plan formulation process, each measure of the TSP, as well as those measures the District also considered. The TSP includes: restoration of aquatic and topographic diversity, including forestry and SSP habitat, island restoration and protection, and timber stand improvement of bottomland hardwood forest. Refer to Appendix M, *Engineering Design,* for quantities and design details.

1. Aquatic Diversity Measures. Dredge cuts were designed to 60-feet bottom width where practicable. In some locations, the bottom width is narrowed down to 30 feet to avoid excavating land above the water surface. Side slopes of the dredge cut were designed at 4H:1V. Excavation would be to 8 feet below Flat pool, or elevation 563.2 feet NAVD88.

2. Topographic Diversity Measures. Topographic diversity sites were selected based on current vegetation quality and the proximity to potential dredge cut locations, as well as accessibility with construction equipment. Sites will be raised to an elevation of 576.2 feet NAVD88 and planted with tree species. A phased planting approach will be used to increase the probability of plant survivability and overall site success. Approximately 1.3 acres of tree clearing will be required to allow access to Grant Slough Placement sites 4 and 5, though the area will be re-planted when construction is complete.

3. Scrub-shrub/Pollinator (SSP) Habitat Measures. SSP sites were determined based on presence of low value vegetation dominated by reed canary grass and suitability of that site to support SSP vegetation, as well as accessibility with construction equipment. Sites will be raised to an elevation of 573.1 feet NAVD88 and planted with SSP species. A phased planting approach will be used to increase the probability of plant survivability and overall site success.

4. Island Protection and Restoration Measures. Island restoration sites were selected to build off existing islands and restore island footprint that has been lost from erosion. These measures include a combination of open water and bankline placement of dredged material and stone protection.

5. Timber Stand Improvement (TSI) Measures. Corps' foresters will continue to implement TSI measures at various locations within the Project area. These measures include tree plantings, thinning treatments, and non-desirable vegetation maintenance. It is estimated approximately 900 acres of active TSI strategies will be implemented in the next 10 years within the Project area.

6. General Description of Dredged and Fill Material. An estimated total of 510,692 cubic yards (cy) of material will be mechanically excavated within the Project area. Geotechnical soil borings from the pools indicate the material is soft lean clays and fat clays with an underlying layer of medium to fine sand. Elutriate testing or sieve analyses are not required (under Section 401 of the Clean Water Act) for this Project because material is unlikely to be a carrier of contaminants based on the HTRW Phase 1 assessment [40 CFR230.60 (b)]. In addition, the discharge and extraction sites are adjacent to one another and thus subject to the same source of contaminants [40 CFR230.60 (c)].

An estimated total of 131,622 tons (TN) of clean riprap will be used to restore and protect the head of Upper Steamboat Island (USI Head) (102,941 TN), the Northeast Bank (NE Bank) (22,403 TN), the West SE Island (6,115 TN), and to construct the Grade Control Structure (GCS) (162 TN) (Appendix P, *Plates*, Plate 8, C-102). During the pre-construction engineering and design (PED) phase of the Project, river stone will likely be incorporated on the slopes and toes of stone protection placement in the water to further enhance preferred mussel habitat. Only 1.3 acres of tree removal will be required for dredged material placement site access. To allow for any excess dredging that may occur, the dredged material will be placed within the topographic diversity sites that have a total capacity for 504,380 cy of material. Refer to Table B-1 for further details on the quantities for dredge cuts and placement.

Appendix B
Clean Water Act Section 404(b)(1) Assessment: NWP 27 Justification

Table B-1: Excavation and Fill Data Summary

	Dredging		Placement		
Dredge Cuts & Placement Sites	**Length (linear ft)**	**Dredging Quantity (cy)**	**Stone Length**	**Capacity (cy)**	**Stone (TN)**
SI Upper Lake	6,902	194,828	–	–	–
SI Lower Lake	5,758	170,158	–	–	–
Grant Slough Lake	3,377	87,704	–	–	–
Access to Grant Slough	3,017	10,721	–	–	–
Access to SE Island	372	855	–	–	–
Restore USI Head	–	–	3,863	274,530	102,941
NE Bank	–	–	1,589	30,990	22,403
West SE Island	–	–	418	76,020	6,115
SI Upper Lake Placement Site	–	–		10,972	–
Grant Slough Placement 2	–	–		11,886	–
Grant Slough Placement 4 & 5	–	–		47,503	–
GCS	–	–	264	561	162
Grant Slough Placement 1 (SSP)	–	–	–	3,077	–
Lower Lake SSP	–	–	–	2,988	–
Totals in Draft TSP	19,426	464,266	6,134	458,527	131,622
Totals in Draft TSP (accounts for shrinking/bulking)	**19,426**	**510,692**	**6,134**	**504,380**	**131,622**

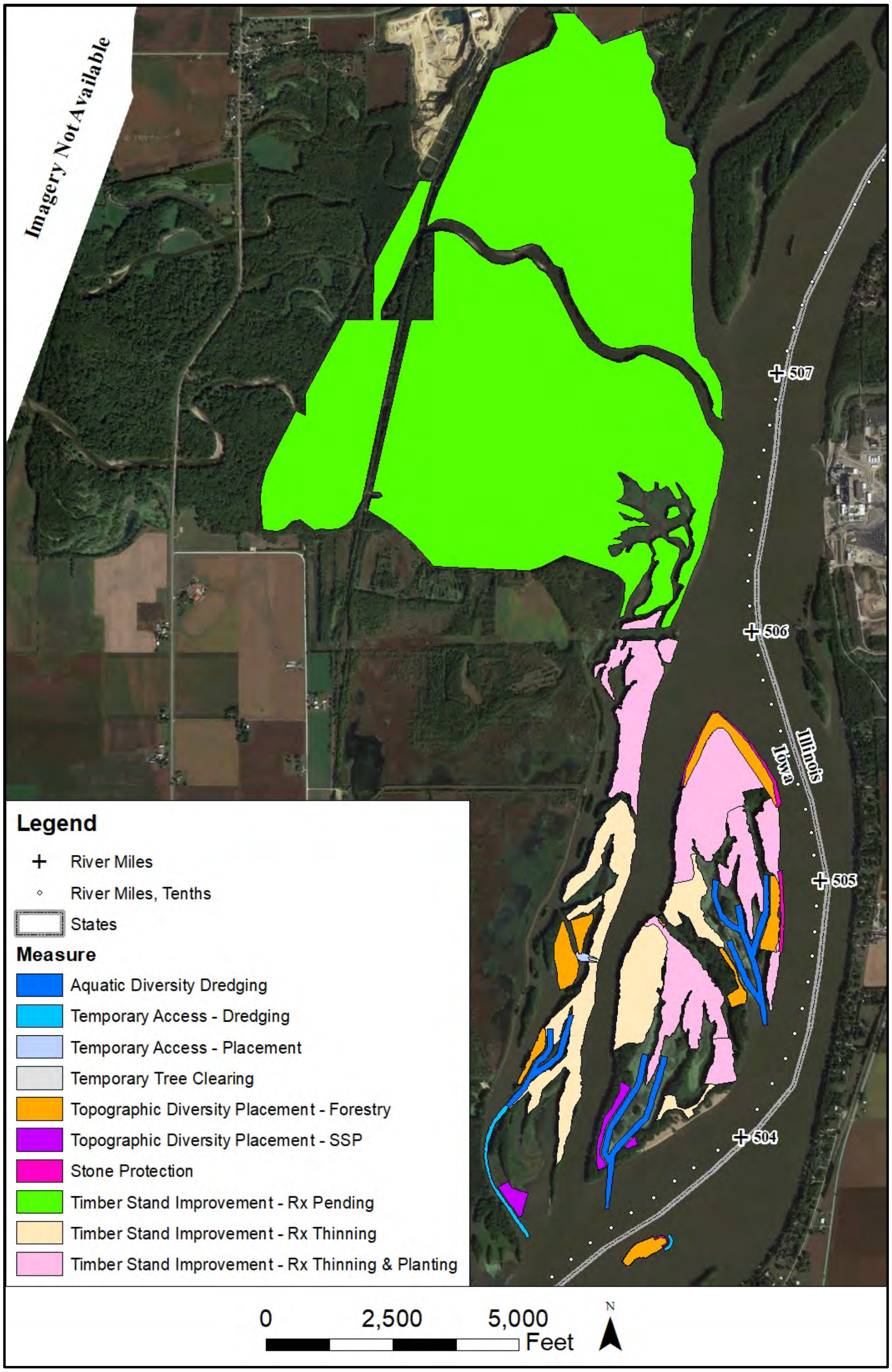

Figure B-1: TSP Measures

IV. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

1. Substrate Elevation and Slope. Flat pool in the Project area is approximately elevation 571.2 (Lock and Dam 14, Le Claire, Iowa). The proposed Project measures intend to increase the floodplain elevation to increase topographic diversity. The maximum elevation of the dredged material placement sites is at elevation 576.2' NAVD88 for floodplain forest sites and 573.1' NAVD88 for SSP sites. Stone protection top elevation will be 574.0' NAVD88 at the West SE Island, 574.7' NAVD88 at the Head of Steamboat Island and 575.25' NAVD88 at the NE Bank. All stone will have slopes of 3H:1V river side and 1.5H:1V land side where applicable. Mussel substrate may be incorporated to stone protection on the slopes and toe of stone placement in the water.

2. Sediment Type. Surficial soils within the placement sites are generally fluvaquent soils, which is described as an alluvium product in the NRCS classification system. This series is described as frequently flooded and water table is said to vary between ground surface and 1 foot deep. Subsurface borings indicate the Project area generally consists of lean, medium, and fat clays gradually changing into stiff clay with increasing depth. This clay layer was underlain sporadically with medium to fine sand lenses.

3. Excavated/Fill Material Movement. Excavated material placement sites are in areas located above flat pool or low flow conditions, which indicates minimal movement of materials. Placement areas will be heavily planted with native hard mast and other floodplain trees, scrub-shrub species, and native grass species, which will help to ensure stability. Flat slopes have been designed to reduce any loss of slope or height that may occur as a result of settling or erosion during high flow events (2-year flood). Rock placement should experience minimal material movement. Adequate rock size is proposed to reduce settling and material movement during high flow events.

4. Physical Effects on Benthos. Any immobile benthos present at the placement site would be buried as a result of construction activities. With the increase in aquatic vegetation, woody debris, and rock, benthic organisms should recolonize quickly.

5. Actions Taken to Minimize Impacts. The construction footprint was kept as small as possible to minimize impacts to the benthic community. Construction materials to be used are physically stable and clean, reducing the chances for impacting the river. Mechanical excavation prevents excess water runoff back into the river and reduces instability by keeping the material consolidated. Tree plantings, ground cover, and erosion control materials will be installed following berm shaping.

B. Water Circulation, Fluctuation, and Salinity Determinations

1. Water. No significant differences in water chemistry are expected following Project construction, and no violations of applicable state water standards are anticipated. The rock materials are inert material that would have little effect on water chemistry. Water clarity, odor, taste, pH, temperature, and dissolved gas levels would not change. The nature of all fill materials would not cause any significant changes in nutrient levels. The construction should not impair the aquatic ecosystem's capability to sustain life, or reduce the suitability of the Mississippi River for aquatic organisms, human consumption, recreation, or aesthetics.

2. Current Patterns and Circulation. Shallow water placements could have a minor effect on flow patterns in the immediate vicinity of the structures. However, no measurable reductions of inflow to backwater areas are anticipated. No significant effects to existing current patterns or water circulation are expected to result from this action.

3. Normal Water Level Fluctuation. No changes in normal water level fluctuations are anticipated to result from the proposed Project.

4. Salinity Gradient. This consideration is not applicable in the location of the proposed Project.

5. Actions Taken to Minimize Impacts. The construction footprint was kept as small as possible and measures were designed and aligned to minimize any potential for adverse effects to water circulation and fluctuation.

C. Suspended Particulate/Turbidity Determinations

1. Expected Changes in Suspended Particles and Turbidity Levels in Vicinity of Placement Site. Suspended solids and turbidity values would be expected to temporarily increase during excavation and placement. A return to ambient conditions should occur shortly after completion of construction. No long-term impacts to suspended solids and turbidity levels are anticipated.

2. Effects on Physical and Chemical Properties of the Water Column

- **Light Penetration.** The Project would have short-term adverse impacts during construction due to turbidity plumes. Following construction, turbidity and associated light penetration would be expected to return to pre-construction levels.

- **Dissolved Oxygen (DO).** Placement of excavated material should have no short- or long-term adverse impacts on DO levels. Aquatic diversity measures should help to maintain DO in the Project area at levels (5 mg/l minimum) suitable for year-round fish habitat.

- **Toxic Metals and Organics.** No increase in contaminants in the aquatic environment would result from the placement of fill material. Excavating and placement of fine material is not expected to have toxic effects on fish, wildlife, or other aquatic organisms.

- **Aesthetics.** Temporary increases in suspended sediments would have a minor short-term impact on aesthetics in the Project area. No long-term negative effects on aesthetics are anticipated to result from the Project.

3. Effects on Biota. Minor disturbances to organisms present in the construction zone could occur as a result of fill activity and excavating. These disturbances are short-term and are offset by the overall lift to the local natural resources.

D. Contaminant Determinations. No contaminants that would exceed State standards have been identified in substrates to be excavated. Possible introduction by equipment or construction-related contaminants would be controlled by adherence to runoff monitoring plans during construction activity. No toxic materials would be introduced to the area as a result of construction activities. Rock riprap would be clean, uncontaminated stone from an approved source.

E. Aquatic Ecosystem and Organism Determinations

1. Effects on Plankton. Only short-term and minimal effects are anticipated to occur as a result of excavating and fill activity. No significant impacts to plankton are expected.

2. Effects on Benthos. No significant impacts to benthos at the placement site or at the location of mechanical excavating are anticipated. For the most part, aquatic substrates would be affected incidentally to adjacent construction activities. Aquatic substrates would be directly affected by mechanical excavating. These substrates would eventually be covered with material of similar character. Recolonization of benthic organisms should occur quickly.

3. Effects on Nekton. The restoration of backwaters would substantially improve the quality of fish habitat in this area. The primary factor that is limited at present and at risk in the future is overwintering habitat, due to limited deep off-channel aquatic areas protected from high current velocities. Channel excavation in the aforementioned backwater lakes would ensure areas of suitable depth, flow, dissolved oxygen, and temperature would be available during severe winter conditions in the future.

4. Effects on Aquatic Food Web. The loss of the benthic organisms within the footprint of the riprap bank protection should not cause any significant impact to any level/segment of the aquatic food web, or disrupt the flow of energy between trophic levels. This small benthic loss should not result in the reduction or potential elimination of food chain organism populations and should not cause any decrease in the overall productivity and nutrient export capability of the ecosystem.

Improvements in backwater and riverine habitat through aquatic vegetation establishment, spawning and overwintering habitat protection, and increased depth should increase primary and secondary production in the Project area. This increase in production should lead to an increased forage base for fish and wildlife.

5. Effects on Special Aquatic Sites

- **Sanctuaries and Refuges.** The Project area is located within the UMR NWFR. There are many designated “closed areas” found in the Refuge, but none of these occur within or will be impacted by the Project area.

- **Wetlands, Mud Flats and Vegetated Shallows.** The Project area contains 2,013 acres of interconnected backwaters, secondary channels, wetlands, and floodplain habitat. The Project involves excavating material from Upper and Lower Steamboat Island Lakes and NW Grant Slough Lake to restore approximately 42 acres of backwater overwintering habitat. In order to be considered a wetland under the 1987 Corps of Engineers Wetland Delineation Manual, three criteria are required: *hydric soils, hydrophilic vegetation, and hydrology*. The following describes how the proposed sites will stay within this criteria after placement of material to provide topographic diversity:

  - ***Hydric Soils.*** Section IV.A above outlines the types of soils that are present in and around the Project area, which are generally classified as Ambraw-Perks-Lawson complex, which is described as an alluvium product in the NRCS classification system. Borings were taken approximately 12 feet deep from the top of water elevation (575.35 NAVD88). Below ground surface materials depths ranged between 4.5 and 7.0 feet and are composed of lean, medium, and fat clays. Atterberg limit tests were performed on several of the clay samples gathered throughout the site. Results for liquid limits ranged between 45 and 83, and plastic limits between 20 and 32 (for more detail, see Appendix G, *Geotechnical Considerations*).

  - ***Vegetation.*** The dominant wetland type that currently exist in the Project area is considered freshwater forested. Following placement of the excavated material, 67 acres of reed canary grass monocultures will be converted to higher quality bottomland hardwoods. Roughly 51% of the island is at an elevation (> 574 feet) suitable to contain hard mast producing trees; however, there are very few areas currently supporting hard mast trees and those that are present are on average over 88 years (ranged 1874 to 1964) old and contain little production in the understory. This lack of production is directly related to increased water inundation and duration. Current topography shows a significant portion of the Project is low in elevation and below the threshold for producing a sustainable hard mast producing tree population and it is highly unlikely present trees will regenerate without intervention in the next 50 years. The proposed plan effectively works to stop and reverse this trend; thus, increasing habitat availability and quality for migratory birds (i.e., neotropical, waterfowl, bald eagle, heron rookeries), endangered species (i.e., Indiana bat, northern long-eared bats), general wildlife, reptiles and amphibians, etc.

    The placement sites will either be sloped to drain, or will have +0’ to -1.5’ elevation changes to create swales across the wider sites. Once shaping is complete, temporary seeding may be employed if permanent seeding cannot occur immediately. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and be surrounded by buffer species as listed in Appendix M, *Engineering Design*.

    According to the Corps’ National Wetland Plant List and Indicator Rating Definitions, obligate indicator status is defined as occurring at a 99% rating under natural conditions in wetlands. Currently, the obligate species *Cephalanthus occidentalis* (buttonbush) is present above elevations of 573.1 in the Project area. Therefore, it is assumed that the wetland vegetation planted at/or above 573.1 feet will be successful for the life of the Project.

o ***Hydrology.*** Corps Regulatory defines wetland hydrology (1987 Corps of Engineers Wetlands Delineation Manual) as inundation or saturation to the surface continuously for at least 5% of the growing season in most years (50% probability of recurrence). Utilizing further guidance in this manual, the growing season for Clinton County was established using the NOAA Regional Climate Center AgACIS output for the days above 28 degrees F with a 50% chance of the growing season occurring therein, and the 1987-2016 period of temperature record. The resulting growing season was April 12 to October 20. Five percent of the growing season (191 days) is equivalent to 9.55 days which is rounded to 10. The USACE Regulatory team member provided that a 14-day analysis is preferred over 5% of the growing season (10-day). River stages at the Camanche gage (RM 511.8) for the 20-year period 1997-2016 were used in HEC-EFM to determine the maximum of the 14-day minimum elevations (during the growing season) that has a 50% probability of occurring. The resulting elevation was interpolated upstream to the Project location (RM 504.5) and converted to the NAVD88 datum arriving at elevation 574.9 feet. The upper limit for the tree planting elevation was based upon the 25 percent exceedance probability for the minimally tolerant growing season inundation criteria (25-day inundation duration), which is 575.2 feet at RM 504.5. In compliance with ECB 2014-10, consideration of climate change and future hydrologic conditions during the 50-year period of analysis was given with the appropriate floodplain forest design elevation selected at a maximum of 576.2 feet. While the maximum wetland elevation in this area was lower than the maximum elevation selected by the PDT for the proposed Project, the 1987 Corps Regulatory Manual does not include consideration of climate change and future hydrology.

6. Threatened and Endangered Species. No bat surveys have been conducted for the Project. Only 1.3 acres of tree clearing will be required for access to topographic diversity sites, which will be conducted outside the maternity roost season. Two summer mussel surveys resulted in the identification of low to moderate quality mussel habitat and no federally-listed species were recovered in the proposed design footprint. The overall forested habitat which exists in the Project area is approximately 1,674 acres. When compared to the number of acres potentially affected by the Project, the District determined tree clearing to be about 0.07 percent of the total.

The proposed excavating of the backwaters in the Project area should have no direct impacts to the Higgins eye pearly mussel since the backwaters do not appear to contain suitable habitat. It is estimated approximately 900 acres of active TSI strategies will be implemented in the future in the Project area.

Correspondence from the USFWS indicates no impacts are anticipated to threatened or endangered species or their habitats, provided construction activities are scheduled and monitored to avoid direct impacts, conservation measures are implemented, and conditions do not change significantly (Appendix A, *Correspondence*).

7. Other Wildlife. Wildlife species that utilize forested and non-forested wetland habitats should benefit in the long term from the proposed action.

F. Proposed Placement Site Determinations

1. Mixing Zone Determinations. Discussions pertaining to turbidity and suspended particulates are summarized in Section II. I. Contaminants were discussed previously in Section II, N. A small amount of fine-grained material could migrate from the placement sites and become diluted with adjacent side channel and main channel border flow. Fine-grained material used for construction of the topographic diversity feature would result in temporary localized increases in suspended material. The use of mechanical excavating should help to minimize these effects.

2. Determination of Compliance with Applicable Water Quality Standards. Due to the nature of this Project and the proposed aquatic habitat improvement, it will be covered under Nationwide Permit 27, which includes Section 401 Water Quality Certification for the States of Illinois and Iowa, under Section 404 of the Clean Water Act.

3. Potential Effects on Human-Use Characteristics. Implementation of the proposed Project will have no significant adverse effects on municipal or private water supplies; recreational or commercial fisheries; water-related recreation or aesthetics; parks; national monuments; or other similar preserves.

4. Determination of Cumulative Effects on the Aquatic Ecosystem. The District continues the operation and maintenance of the 9-foot Navigation Channel Project. This includes continuation of excavating and placement of sediment and dike construction (i.e., chevrons, closing structures, and wing dams).

Corps' foresters will continue to implement TSI measures at locations within the Project area. These measures include tree plantings, thinning treatments, and non-desirable vegetation maintenance. These efforts will continue in the future on the island. It is estimated approximately 900 acres of active TSI strategies will be implemented for the duration of the Project.

It is anticipated within the next 10 years, the Steamboat HREP and other HREP Projects will commence planning efforts for implementation. These would be similar to Steamboat Island with objectives for increased backwater depth, topographic diversity, floodplain vegetation diversity, and restored aquatic processes.

Cumulative impacts of the proposed action are not expected to be significant. The Project offers a unique opportunity to restore and enhance fish and wildlife resources in this section of Pool 14. The multi-agency coordination effort has demonstrated the value of this Project towards maintaining a high quality UMR ecosystem while avoiding adverse impacts. Steamboat Island HREP, Beaver Island HREP, and Princeton Refuge HREPs represent a cumulative synergy of habitat restoration in Pool 14 to restore degraded environmental conditions within the backwater and floodplain forest habitats that will benefit migratory birds, fish, other wildlife, and plants.

5. Determination of Secondary Effects on the Aquatic Ecosystem. No significant secondary effects should result from construction of the proposed Project.

V. NATIONWIDE PERMIT (NWP) COMPLIANCE DOCUMENTATION

In order to use a NWP, the Project must comply with four sets of conditions:

- General NWP conditions
- NWP 27 special conditions
- IL-EPA 401 Water Quality Certification conditions
- Iowa 401 Water Quality Certification conditions

For the full language of NWP permit conditions and NWP 27 special conditions, refer to the District's Regulatory Branch website for *Nationwide Permits – Illinois* and *Nationwide Permits – Iowa* links.

Table B-2 shows the 32 general NWP conditions and the District's compliance responses.[1] Table B-3 shows the eight NWP 27 special conditions and the District's compliance responses[1]. There are nine Illinois Regional Conditions for NWP use. Table B-4 documents the District's response to each Condition.

The Illinois Environmental Protection Agency (IEPA) has conditioned Section 401 water quality certification applicable to NWP 27. Department of the Army authorization pursuant to Section 404 of the CWA (33U.S.C.1344) under NWP 27 would be subject to the IEPA conditions. All activities conducted under NWP 27 shall be in accordance with the provisions of 35 Il. Adm. Code 405.108.

Table B-5 shows the IEPA Section 401 Water Quality Certification conditions for NWP 27 and the District's compliance responses[1].

Iowa has conditioned Section 401 water quality certification applicable to NWP 27. Department of the Army authorization pursuant to Section 404 of the CWA (33U.S.C.1344) under NWP 27 will be subject to the Iowa conditions. Table B-6 shows the Iowa Regional Conditions Section 401 Water Quality Certification conditions for NWP 27 and the District's compliance responses.

VI. CONCLUSION

The planning team concludes this Project meets the conditions of CWA, Section 404 by an existing Department of Army NWP for aquatic habitat restoration, establishment and enhancement activities, as described in the January 6, 2017, Federal Register, Reissuance of Nationwide Permits; Notice (82 FR 1860).

The District and USFWS realize NWP 27 may be modified, reissued, or revoked prior to construction or on March 19, 2022. The planning team would remain informed of changes to the NWPs. If

[1] The Main Report contains detailed discussions on most of these topics. If the Main Report does not address the condition, a detailed response is presented in these tables.

construction activities are not completed prior to 12 months from the date of the modifications or revocation of the NWP, the team would reevaluate the Project's 404(b)(1) compliance status and would coordinate the Project with the District's Regulatory Branch. The Project would be in full compliance with the current CWA regulations prior to any construction and activities.

Table B-2: General NWP Conditions and Compliance Responses

#	General NWP Condition	Compliance Response
1	Navigation	No navigation impacts expected. Project measures would not impact the 9-foot navigation channel in the UMRS. The Project would not impact barge operation, safety, or tow handling. The Project would not impact recreation boating.
2	Aquatic Life Movements	Positive impacts expected with Project objective of creating year-round fish habitat.
3	Spawning Areas	Project measures anticipated to improve quality spawning habitats over the life of the Project for fish and wildlife. This quality would last over the life of the Project.
4	Migratory Bird Breeding Areas	Project measures would not negatively impact emergent wetland habitat for bird nesting habitat (see Appendix D).
5	Shellfish Beds	No shellfish beds present in the Project area
6	Suitable Material	Only local material (sand and clay) would be used for topographic diversity placement sites. Planted trees would be from local seed sources and flood tolerant.
7	Water Supply Intakes	No public water supply intakes present in the Project area.
8	Adverse Effects From Impoundments	No anticipated impoundments as part of the Project.
9	Management of Water Flows	Project measures would handle fluctuating water levels including fluctuating river levels.
10	Fills Within 100-Year Floodplains	This Project would comply with applicable FEMA approved floodplain management requirements.
11	Equipment	Use of heavy equipment would be done in dry conditions and would not impact the water column clarity or water quality standards. If construction would take place in wet conditions, turbidity would be short term and no material would be allowed to migrate off site.
12	Soil Erosion and Sediment Controls	The Project would require standard construction guidelines to avoid erosion and sediment re-suspension.
13	Removal of Temporary Fills	Temporary coffer dams would be removed and their locations would be restored to preconstruction conditions.
14	Proper Maintenance	The USFWS would maintain Project measures over the 50-year Project life.
15	Single and Complete Project	The Project would be a single project.
16	Wild and Scenic Rivers	Not Applicable
17	Tribal Rights	Not Applicable

Table B-2: General NWP Conditions and Compliance Responses

#	General NWP Condition	Compliance Response
18	Endangered Species	Full Compliance. See Main Report Section IX.E.
19	Migratory Birds and Bald and Golden Eagles	An eagle nest at the USI head was last observed as active in 2017. Any tree thinning would be minimal near this area to avoid disturbance. Seasonal limitations will be in compliance with USFWS regulations.
20	Historic Properties	Pending; anticipate Full Compliance. See Main Report Section IX.G.
21	Discovery of Previously Unknown Remains and Artifacts	The District Engineer would be notified immediately and coordination initiated, if previously unknown remains and artifacts are discovered.
22	Designated Critical Resource Waters	This Project is not located in or contains any Designated Critical Resource Waters
23	Mitigation	This Project would not require wetland mitigation.
24	Safety of Impounded Structures	Not Applicable.
25	Water Quality	This Project would comply with the Illinois & Iowa water quality standards (See Tables B-4, B-5 and B-6.)
26	Coastal Zone Management	Not Applicable
27	Regional and Case-By-Case Conditions	Not Applicable
28	Use of Multiple Nationwide Permits	The Project PDT requests only NWP 27.
29	Transfer of NWP Verifications	The PDT anticipates USFWS management of the Project site for the 50-year Project life.
30	Compliance Certification	The USFWS would submit the compliance certification upon receipt of the NWP.
31	Activities Affecting Structures or Works Built by the United States	This Project does not require Section 408 permission.
32	Pre-Construction Notification	Full compliance expected.

Table B-3: Nationwide Permit 27 Conditions and Compliance Responses

#	NWP 27 Condition	Compliance Response
1	Project Intent. Does it meet the intent of aquatic habitat restoration, establishment, and enhancement activities?	This Project's goals and objectives (Main Report Section III, G.) meet the intent of aquatic habitat restoration, establishment, and enhancement.
2	Tidal Areas	This Project does not include any tidal areas
3	Net increase in aquatic resource function and services.	Project measures would provide quality aquatic resources/habitats over the life of the Project for fish and wildlife. Without Project, bottomland floodplain and aquatic habitat would decline from extended inundation periods and sedimentation of backwaters. See Appendix D, which demonstrates a net increase in habitat value.
4	Project features meet the NWP intent	Project measures include backwater dredging to restore aquatic diversity, dredge placement to enhance topographic diversity of bottomland forest and SSP habitat, and island restoration and protection.
5	Alteration of a stream or natural wetlands is prohibited	The proposed Project would not alter any stream or areal quantity of wetland habitats.
6	Reversion	Not applicable
7	Reporting	Full compliance expected.
8	Notifications	Full compliance expected.

Table B-4: Illinois Regional Conditions and Compliance Responses

#	Illinois Regional Condition	Compliance Response
1	Stormwater management facilities shall not be located within a stream,	The Project is not a stormwater project.
2	For newly constructed channels through areas that are unvegetated, native grass filter strips, or a riparian buffer with native trees or shrubs, a minimum of 25 feet wide from the top of bank must be planted along both sides of the new channel. A survival rate of 80% of desirable native species with aerial coverage of at least 50% shall be achieved within 3 years of establishment of the buffer strip.	Aquatic diversity sites were aligned with deepest parts of existing backwater areas to minimize dredging and design with nature. Channels are offset of 30 feet from topographic diversity sites, which will be planted with floodplain forest or SSP species and are designed to heights for plant survivability. A phased planting approach and adaptive management strategy will be employed to ensure plant survival.
3	Side slopes of a newly constructed channel will be no steeper than 2:1 and planted to permanent, perennial, native vegetation if not armored.	The proposed channels would have side slopes greater than 2H:1V. Since they are underwater, the slopes would quickly revegetate.
4	For a single-family residence authorized under Nationwide Permit No. 29, the permanent loss of waters of the United States (including jurisdictional wetlands) must not exceed 1/4 acre.	Not applicable.
5	For NWP 46, the discharge of dredged or fill material into ditches and canals that would sever the jurisdiction of an upstream water of the United States from a downstream water of the United States is not allowed.	Not applicable.
6	For NWP 52, no project will be authorized within Lake Michigan. An individual permit will be required.	Not applicable.
7	Any bank stabilization activity involving a method that protrudes from the bank contours, such as jetties, stream barbs, and/or weirs, will require a pre-construction notification in accordance with General Condition 32.	No bank stabilization would involve a method that protrudes from the existing bank contours.
8	Mitigation shall be constructed prior to, or concurrent with, the discharge of dredged or fill material into waters of the United States unless an alternate timeline is specifically approved in the authorization.	No mitigation is proposed for this ecosystem restoration and enhancement project.
9	Operation of heavy equipment within the stream channel should be avoided. If in-stream work is unavoidable, it shall be performed in such a manner as to minimize the duration of the disturbance, turbidity increases, substrate disturbance, bank disturbance, and disturbance to riparian vegetation. This condition does not further restrict otherwise authorized drainage ditch maintenance activities.	All heavy equipment operation would use BMPs to reduce turbidity and substrate and vegetation disturbances.

Table B-5: IEPA Section 401 Water Quality Certification for NWP 27 Conditions

#	IEPA Section 401 Water Quality Certification for NWP 27	Compliance Response
1	All activities conducted under NWP 27 shall be in accordance with the provisions of 35 Ill. Adm. Code 405.108. Work in reclaimed surface coal mine areas are required to obtain prior authorization from the Illinois EPA for any activities that result in the use of acid-producing mine refuse.	Not applicable. No acid-producing mine refuse would be used in this Project
2	The applicant shall not cause: **a.** violation of applicable provisions of the IEPA; **b.** water pollution defined and prohibited by the IEPA; **c.** violation of applicable water quality standards of the Illinois Pollution Control Board, Title 35, Subtitle C: *Water Pollution Rules and Regulation*; **d.** interference with water use practices near public recreation areas or water supply intakes.	Full compliance expected. A public boat launch is within the Project area; access to the area would be limited during construction.
3	All areas affected by construction shall be mulched and seeded as soon after construction as possible. The applicant shall undertake necessary measures and procedures to reduce erosion during construction. Interim measures to prevent erosion during construction shall be taken and may include the installation of sedimentation basins and temporary mulching. All construction within the waterway shall be conducted during zero or low flow conditions. The applicant shall be responsible for obtaining an NPDES Storm Water Permit prior to initiating construction if the construction activity associated with the project will result in the disturbance of 1 or more acres, total land area. An NPDES Storm Water Permit may be obtained by submitting a properly completed Notice of Intent form by certified mail to the Agency's Division of Water Pollution Control, Permit Section.	Full compliance expected. Contractor would acquire NPDES permits, if required. Contractor would use erosion reduction BMPs.

Table B-6: Iowa Regional Conditions and Section 401 Water Quality Certification for NWP 27 Conditions

#	Iowa Section 401 Water Quality Certification for NWP 27	Compliance Response
1	Side slopes of newly constructed channel will be no steeper than 2:1 and planted to permanent, perennial, native vegetation if not armored.	The proposed channels would have side slopes greater than 2H:1V. Since they are underwater, the slopes would quickly revegetate.
2	Nationwide permits with mitigation may require recording of the nationwide permit and pertinent drawings with the Registrar of Deeds or other appropriate official charged with the responsibility for maintaining records of title to, or interest in, real property and require the permittee to provide proof of that recording to the Corps.	The Project does not require mitigation.
3	Mitigation shall be scheduled prior to, or concurrent with, the discharge of dredged or fill material into waters of the United States, unless an alternate timeline is specifically approved in the authorization.	Not applicable.
4	For newly constructed channels through areas that are unvegetated, native grass filter strips, or a riparian buffer with native trees or shrubs a minimum of 35 feet wide from the top of the bank must be planted along both sides of the new channel. A survival rate of 80 percent of native species shall be achieved within 3 years of establishment of the buffer strip.	Aquatic diversity sites were aligned with deepest parts of existing backwater areas to minimize dredging and design with nature. Channels are offset of 30 feet from topographic diversity sites, which will be planted with floodplain forest or SSP species and are designed to heights for plant survivability. A phased planting approach and adaptive management strategy will be employed to ensure plant survival.
5	For single-family residences authorized under nationwide permit 29, the permanent loss of waters of the United States,(including jurisdictional wetlands, must not exceed ¼ acre.	Not applicable.
6	For nationwide permit 46, the discharge of dredged or fill material into ditches that would sever the jurisdiction of an upstream water of the United States from a downstream water of the United States is not allowed.	Not applicable.
7	For projects that impact an Outstanding National Resource Water, Outstanding Iowa Water, fens, bogs, seeps, or sedge meadows, a Pre-Construction Notice in accordance with General Condition No. 32 and an Individual Section 401 Water Quality Certification will be required.	Mississippi River is a Special Waters of Concern and Project will be coordinated for comments.

Table B-6: Iowa Regional Conditions and Section 401 Water Quality Certification for NWP 27 Conditions

#	Iowa Section 401 Water Quality Certification for NWP 27	Compliance Response
8	For nationwide permits when the Corps District Engineer has issued a waiver to allow the permittee to exceed the limits of the nationwide permit, an individual Section 401 Water Quality Certification will be required.	Not applicable.
9	Operation of heavy equipment within the stream channel should be avoided. If in-stream work is unavoidable, it shall be performed in such a manner as to minimize the duration of the disturbance, turbidity increases, substrate disturbance, bank	Heavy equipment will be used and operated within the stream channel. However, it shall be performed in such a manner as to minimize the duration of the disturbance, turbidity
10	Any bank stabilization activity involving a method that protrudes from the bank contours, such as jetties, stream barbs, and/or weirs, will require a pre-construction notification in accordance with General Condition 32.	No bank stabilization would involve a method that protrudes from the existing bank contours.
11	Beyond what is described in General Condition #6, suitable fill material shall consist of clean materials, free from debris, trash, and other deleterious materials. If broken concrete is used as riprap, all reinforcing rods must be cut flush with the surface of the concrete, and individuals pieces of concrete shall be appropriately graded and not exceed 3 feet in any dimension. Asphalt, car bodies, and broken concrete containing asphalt, and liquid concrete are specifically excluded.	Only local material (sand and clay) would be used for topographic diversity placement sites. Planted trees would be from local seed sources and flood tolerant.
12	No non-native, invasive or other plant species included on the Corps "Excluded Plant List" shall be planted for re-vegetation or stabilization purposes. To prevent the spread of non-native and/or invasive plant species, the permittee shall ensure that equipment to be utilized in Water of the United States is cleaned before arriving on site. Wash water shall not be discharged into any wetland, waterway,	Only native vegetation will be planted as part of the Project. Many of the topographic diversity sites to be planted occur on sites currently occupied by reed canary grass monocultures.

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX B

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

FINDINGS OF COMPLIANCE OR NONCOMPLIANCE WITH CWA AND NWP 27

1. Alternatives considered for the proposed action are as follows:

   Alternative A: No Federal Action

   Alternative B: Tentatively Selected Plan. This includes dredging deep water habitat, placement and shaping of dredged material for the purposes of restoring a diverse forest community, and providing stone protection at various locations in the Project area to reduce island erosion, provide bank stabilization, and improve mussel substrate.

2. No significant impacts to federally-endangered species will result from this Project. The U.S. Fish and Wildlife Service, Ecological Services Office, Moline, Illinois, supports this determination.

3. The proposed Project meets the conditions of Section 404 of the CWA by an existing Department of the Army NWP for aquatic habitat restoration, establishment and enhancement activities as described in the January 6, 2017, Federal Register, Reissuance of Nationwide Permits, Notice (82 FR 1860).

_____________________________   ____________________________________

(Date)

Steven M. Sattinger, P.E.
Colonel, US Army
Commander & District Engineer

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX C

MEMORANDUM OF AGREEMENT

DRAFT MEMORANDUM OF AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY

AND

THE UNITED STATES FISH AND WILDLIFE SERVICE

FOR

HABITAT REHABILITATION AND ENHANCEMENT
OF THE
UPPER MISSISSIPPI RIVER SYSTEM
AT STEAMBOAT ISLAND, MISSISSIPPI RIVER POOL 14,
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

I. PURPOSE

The purpose of this Memorandum of Agreement (MOA) is to establish the relationships, arrangements, and general procedures under which the U.S. Fish and Wildlife Service (USFWS) and the Department of the Army (DA) will operate in constructing, operating, maintaining, repairing, and rehabilitating the *Steamboat Island, Clinton & Scott Counties, Iowa, and Rock Island County, Illinois, Habitat Rehabilitation and Enhancement Project* (Project), a separable element of the Upper Mississippi River Restoration.

II. BACKGROUND

A. The Project lands of the *Steamboat Island, Clinton & Scott Counties, Iowa and Rock Island County, Illinois, Habitat Rehabilitation and Enhancement Project* are owned in fee by the United States of America and managed under the provisions of a cooperative agreement between the DA and the USFWS, dated February 14, 1963, and an amended cooperative agreement dated July 31, 2001.

B. Section 1103 of the Water Resources Development Act (WRDA) of 1986, Public Law 99-662, authorizes construction of measures for the purpose of enhancing fish and wildlife resources in the Upper Mississippi River System. Under conditions of Section 906(e) of the WRDA of 1986, Public Law 99-662, 100 percent of the construction costs of those fish and wildlife features for the Project are the responsibility of the DA. Pursuant to Section 107 (b) of the WRDA of 1992, Public Law 102-580, 100 percent of the costs of operation and maintenance for the Project are the responsibility of the USFWS.

III. GENERAL SCOPE

The Project to be accomplished pursuant to this MOA shall consist of the following:

- Enhancing and restoring areal coverage and diversity of forest stands and habitat and increasing diversity of bottomland hardwood forest in select areas by:
    - increasing existing elevations and planting trees, shrubs, understory plants, and buffer species;
    - performing Timber Stand Improvement (TSI) measures such as tree thinning treatments, tree planting, and invasive species management;

- Increasing year-round aquatic habitat diversity in the Steamboat Island proper backwater in Upper Lake and Lower Lake, as well as Northwest Grant Slough Lake in the Grant Slough complex through excavation and additions of fisheries structure;

- Restoring and protecting acreage and topography of islands within the Project area by placing and protecting dredged material to extend existing island footprints; and

- Protecting existing backwater habitat from sediment deposition and enhancing backwater and interior wetland areas by the construction of a grade control structure at the northwest end of the Cut-Through Channel and establishment of scrub-shrub/pollinator habitat.

IV. RESPONSIBILITIES

A. The Department of the Army Responsibilities

1. Construction. Construction of the Project consists of excavating channels to provide overwintering habitat in backwater areas, constructing topographic diversity sites, to include forest, scrub/shrub, and pollinator habitat restoration and enhancement, implementing TSI techniques, restoring and protecting islands, constructing a grade control structure, and incorporating fish and mussel habitat, where appropriate.

2. Major Rehabilitation. The Federal share of any mutually agreed upon rehabilitation of the Project that exceeds the annual operation and maintenance requirements identified in the Feasibility Report with Integrated Environmental Assessment and that is needed as a result of specific storm or flood events.

3. Construction Management. Subject to and using funds appropriated by the Congress of the United States, and in accordance with Section 906(e) of the WRDA of 1986, Public Law 99-662, the DA will construct the Steamboat Island Habitat Rehabilitation and Enhancement Project as described in the *Upper Mississippi River Restoration, Feasibility Report with Integrated Environmental Assessment, Steamboat Island Habitat Rehabilitation and Enhancement Project*, dated April 2020, applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The USFWS will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. If the DA encounters potential delays related to construction of the Project, the DA will promptly notify the USFWS of such delays.

4. Maintenance of Records. The DA will keep books, records, documents, and other evidence pertaining to costs and expenses incurred in connection with construction of the Project to the extent and in such detail as will properly reflect total costs. The DA shall maintain such books, records, documents, and other evidence for a minimum of 3 years after completion of construction of the Project and resolution of all relevant claims arising therefrom, and shall make available at its offices, at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the USFWS.

B. USFWS Responsibilities

Upon completion of construction as determined by the District Engineer, Rock Island, the USFWS shall accept the Project as part of the General Plans lands managed by the USFWS. The USFWS shall operate, maintain, and repair the Project as defined in the *Upper Mississippi River Restoration, Feasibility Report with Integrated Environmental Assessment, Steamboat Island Habitat*

Rehabilitation and Enhancement Project dated April 2020. In accordance with Section 107(b) of the WRDA of 1992, Public Law 102-580, 100 percent of all costs associated with the operation, maintenance, and repair of the Project will be borne by the USFWS. The DA will develop an Operation and Maintenance Manual for the Project to be provided to USFWS at Project completion and transfer.

V. MODIFICATION AND TERMINATION

This MOA may be modified or terminated at any time by mutual agreement of the parties. Any such modification or termination must be in writing. Unless otherwise modified or terminated, this MOA shall remain in effect for a period of 50 years after initiation of construction of the Project.

VI. REPRESENTATIVES

The following individuals or their designated representatives shall have authority to act under this MOA for their respective parties:

The U.S. Fish and Wildlife Service:	Great Lakes Regional Director U.S. Fish and Wildlife Service 5600 American Boulevard West, Suite 990 Bloomington, Minnesota 55437-1458
The Department of the Army:	District Engineer U.S. Army Engineer District, Rock Island Clock Tower Building P. O. Box 2004 Rock Island, Illinois 61204-2004

VII. EFFECTIVE DATE

This Steamboat Island Habitat Rehabilitation and Enhancement Project MOA shall become effective when signed by the appropriate representatives of both parties.

THE DEPARTMENT OF THE ARMY

____

Steven M. Sattinger, P.E
Colonel, US Army
Commander & District Engineer

Date _______________________

USDI FISH AND WILDLIFE SERVICE

____

Charles Wooley
Regional Director, Region 3
U.S. Fish and Wildlife Service

Date _______________________

UPPER MISSISSIPPI RIVER RESTORATION
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APPENDIX D

HABITAT EVALUATION AND BENEFITS QUANTIFICATION

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
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STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

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APPENDIX D

HABITAT EVALUATION AND BENEFITS QUANTIFICATION

TABLES

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
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STEAMBOAT ISLAND
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AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX D

HABITAT EVALUATION AND BENEFITS QUANTIFICATION

I. INTRODUCTION

This appendix presents the *Steamboat Island Habitat Restoration and Enhancement Project* (Project) habitat analysis and benefit quantification that informed the CEICA used by the PDT to evaluate all possible Project alternatives and ultimately determine the TSP. This assessment includes a summary of the existing biological conditions used in the evaluation, as well as a forecast for future conditions under the No Action Alternative and each potential Project measure. The evaluation was conducted by a multi-agency team of biologists from the USFWS, the IA DNR, the IL DNR, and the District.

These planning procedures are based upon the planning framework established in, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* [P&G (U.S. Water Resources Council, 1983)]. For District environmental planning, where traditional benefit-cost analysis is not possible because costs and benefits are expressed in different units, cost effectiveness and incremental cost analyses offer plan evaluation approaches consistent with the Corps' P&G Program paradigm. This paradigm provides a rational and deliberate approach to solving problems and making decisions, which requires information about future environmental conditions with, and without, the implementations of each alternative plan under consideration. The data, assumptions, and processes used to support these environmental forecasts are outlined below.

II. EXISTING AND FUTURE WITHOUT PROJECT BIOLOGICAL CONDITIONS

A. Aquatic Habitat. Existing water quality data was collected by the District (2014-present); land cover data was obtained through a 2017 topobathymetric LiDAR survey; substrate information was gathered from geotechnical borings and mussel survey data; and velocities were generated from H&H modeling and field collections. Future With and Without Project data was estimated using best professional judgment of the PDT and H&H modeling, when applicable. Inherent in best professional judgment are the underlying assumptions, which are described in Sections III.B and III. C of this Appendix. Section II of the Main Report, *Affected Environment,* includes a description of how these parameters influence fish life history and habitat quality.

B. Floodplain Habitat. Historic floodplain data was obtained through pre-dam topography maps; existing floodplain habitat was derived from a 2018 forest survey and 2017 topobathymetric LiDAR survey data; GIS analyses; H&H modeling; and consensus of the resource managers. Following construction of L&D 14, the physical conditions of the Project area were altered significantly. Since the 1930s, over 140 acres of Steamboat Island and the southeast islands have been lost due to inundation and erosion in succeeding years, which significantly altered the hydrology and forest conditions of the Project area. Where once a diverse forest community, including several hard-mast species, was prominent on the island, now only an even-aged mature silver maple and other flood-tolerant species inhabit the area. Forest stands are mature, even-aged, and experiencing a high rate of mortality without recruitment. Consequently, percent open canopy is increasing, with reed canary grass beginning to dominate those areas.

III. HABITAT BENEFIT EVALUATION METHODS

The purpose of the habitat benefit evaluation is to evaluate and quantify, to the extent possible, environmental benefits of alternative plans for aquatic and floodplain habitat improvements. Aquatic benefits were quantified through the use of Engineering Circular 1105-2-412, *Assuring Quality of Planning Models* and the Upper Mississippi River System Overwintering Bluegill and Walleye Habitat Suitability Index (HSI) Models (HEP; USFWS 1980). Floodplain benefits were quantified through the use of the Gray Squirrel and Yellow Warbler HSI Models (HEP; USFWS 1980).

A. Quantity Component. Traditionally, the Corps has used the quantity and quality of habitat jointly, in the form of habitat units (HUs), to measure benefits provided by ecosystem restoration projects. The quantity portion is often measured as area (acres of habitat, landform, etc.) or number of species; in some systems, it is measured as length (miles of stream bank). The evaluation conducted for the Project uses acres, delineated by polygons, to represent the quantity. The area associated with each management measure must have a clear definition for use as guidance in estimating the area component of the ecosystem output model, and must be applied consistently to all actions evaluated. From the qualitative and quantitative determinations, the standard unit of measure, HU, is calculated using the formula (HSI x Acres = HUs) for all selected HSI models.

With or without a project, habitat conditions change over time; therefore, the overall value of a proposed project depends upon the comparison of expected with-project benefits to expected without-project benefits. Annualized HUs are referred to as average annual habitat units (AAHUs). To assess the change over the period of analysis, the PDT identified target years (TYs) where a change in the habitat variables may be noticed. Noticeable changes are characterized by a change in habitat benefit output. Model TYs by species:

- Bluegill TY: 0, 1, 10, 20, 30, 50
- Walleye TY: 0, 1, 10, 25, 50
- Yellow warbler TY: 0, 1, 20, 30, 50
- Gray squirrel TY: 0, 1, 20, 30, 50

For this Project, the area of the action footprint (physical footprint of management measures) was selected to measure and compare the habitat benefits of each alternative (Table D-1). When multiple management measures are included in an action, the footprint equals the total of the management-measure footprints with no double counting of overlapping areas addressed by two or more management measures. Acreage differs for Future With and Without Project due to the trade-off between unlimiting habitat (ex: wetland) for limiting habitat (ex: aquatic).

There are trade-offs associated with restricting the evaluation of benefits to the action footprint. On the one hand, benefits can be accurately quantified with a high degree of certainty and allow for the development of specific and measurable criteria to be used in monitoring Project performance; however, the action footprint also tends to grossly underestimate the areal extent of ecological benefits because the area of restored biotic/abiotic processes usually covers a much broader scale.

Although the habitat evaluation of the Project was limited to the action footprint, it should be recognized that benefits of various measures likely extend beyond this immediate footprint as biotic and abiotic processes are restored. However, estimating habitat benefits at higher scales (e.g., area of restored process, area of potential influence) was considered too uncertain or speculative to accurately assess.

Table D-1: Habitat Types and Areas Evaluated for this Assessment

Habitat Type	Evaluation Area	Area (acres)	HSI Model
Aquatic	Steamboat Island (Upper and Lower Lakes) – Aquatic Diversity	23	Bluegill
	NW Grant Slough – Aquatic Diversity	6	Bluegill
	Steamboat Slough – Flow Diversity	0.4	Walleye
	West SE Island – Mussel Habitat	1	Walleye
Floodplain[1]	Steamboat Island – Forest Topographic Diversity (3 sites)	14	Yellow Warbler/Gray squirrel
	Steamboat Island – Scrub-Shrub/Pollinator Topographic Diversity (Lower Lake)	5	Yellow Warbler
	USI Head – Forest Topographic Diversity	14	Yellow Warbler/Gray squirrel
	Grant Slough Complex – Forest Topographic Diversity (4 sites)	30	Yellow Warbler/Gray squirrel
	West SE Island – Forest Topographic Diversity	4	Yellow Warbler/Gray squirrel
	TOTAL	**97.4**	

[1] TSI measures were not included in the initial habitat analysis, but they were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project Area. See Sections III.C.3 and IV for methods and results of the Hydrogeomorphic (HGM) Approach that was later applied to support the TSP.

B. Quality of Aquatic Benefits. The methodology utilized for evaluating benefits to aquatic habitat incorporates the HEP format, which was developed by the USFWS. HEP is a habitat-based evaluation methodology used in project planning. The procedure documents the quality and quantity of available habitat for selected fish and wildlife species. HEP is based on the assumption that habitat for selected fish and wildlife species can be described by a HSI. This index value (on a scale from 0.0 to 1.0) is multiplied by the area of applicable habitat to obtain HUs, which are used in comparisons of the relative value of fish and wildlife habitat at points in time.

Changes in HUs will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the life of the Project (50 years). HUs are calculated for select target years and annualized (using IWR Planning Suite NER Annualizer) over the life of the Project to derive AAHUs. AAHUs are used as the output measurement to compare the measures and alternatives for the proposed Project.

1. **Backwater Habitat.** The Corps-approved (per EC 1105-2-412) Bluegill HSI model (Stuber et al. 1982a; Palesh and Anderson 1990) was used to assess the backwater habitat benefits resulting from the aquatic diversity measures at Upper Lake, Lower Lake, and NW Grant Slough. These species were selected because they require backwater habitat for all or most of their life cycle and are often limited in the availability of high quality overwintering habitat. The following assumptions in applying the Bluegill HSI model were made:

Baseline Condition. Detailed water quality data was collected from 2014 to present at monitoring stations in the backwater area. Due to the length of the data collection and location, it was assumed the data collected at each station was representative of the entire backwater. For the purposes of model input, the spawning season was May to June, growing season June to September, and overwintering December to February. It was assumed the water quality entering Steamboat Island interior was similar to Steamboat Slough and the main channel.

Future Without Project Conditions. Future conditions of all backwater lakes were based on an average sediment deposition rate of 1 cm/year over the next 50 years. This rate was determined based on information obtained from IADNR sedimentation studies (Aspelmeier, 1994). It is not likely that aquatic habitat loss would be linear, as most sedimentation occurs during flooding events. Nonetheless, over time aquatic habitat will be reduced significantly. Remaining lentic habitat will consist of isolated interior shallow pools with fish access only during high water events or small (< 0.14 acre) limited overwintering areas. It is probable that the Project area will continue to provide spawning habitat based on future floodplain conditions. Rearing and foraging habitat currently provided by the interior backwaters will be substantially reduced as remaining pool habitat will have impaired water quality or restricted access during average flows. Consequently, summer habitat will shift to another backwater complex or to other flowing channels, if available, in Pool 14. Finally, overwintering habitat will continue to be limited to near zero within the interior backwaters of the Project.

Future With Project Conditions. The proposed final depth of each backwater lake is 8 feet. With approximately 1.6 feet of sediment accumulating over 50 years, adequate depths would still be present for overwintering habitat. Therefore, it was assumed percent backwater greater than 4 feet in depth would increase to near 80% with a slight decrease over time due to sediment deposition on the slopes of the excavation site.

2. **Riverine Habitat.** The Corps-approved (per EC 1105-2-412) Walleye HSI model (McMahon et al. 1984) was used to assess the riverine habitat benefits resulting from West SE Island protection via riprap bank stabilization. Walleye was selected primarily because it is a popular host fish species for numerous freshwater mussels that inhabit the Project area. Walleye is rheophilic (or oriented to flow) and captures the benefits from an increase in forage, water clarity, and spawning habitat afforded by the restoration measures; therefore, the increasing of suitable fish hosts was assumed to have

potential benefits to the freshwater mussel community. The following assumptions in applying the Walleye HSI models were made:

Baseline Condition. Water quality and hydraulic data from the main channel was assumed to be similar to the West SE Island. For the purposes of model input, the spawning season for walleye was March to May and growing season June to October. The 2019 mussel survey confirmed the absence of ideal mussel habitat as substrates were dominated by shifting sand and no mussels were recovered during the quantitative portion of the survey.

Future Without Project Conditions. It was assumed West SE Island would continue to experience erosion at a rate of 0.14 acres per year (see Appendix M, *Engineering Design* for more details on erosion rates). At its current estimated size of 0.36 acres, the island will have completely eroded within the span of a few years. Consequently, available habitat structure and cover, food production, and potential spawning habitat for walleye and mussels would be reduced.

Future With Project Conditions. Restoration and protection of the island would reduce erosion and potentially initiate island growth through reduced year-round velocities and aggradation of sediments. Rock would increase habitat structure for fish cover and because preferred mussel habitat is currently absent, no mussel impacts were assessed for the model. Due to the increase in habitat availability and complexity, cover and forage fish abundance is expected to increase. The stone protection area around the island was multiplied by a factor of 2 to create a “shadow effect” of preferred mussel habitat, amounting to approximately 1 acre. A very important element is the continued structure and function of the island and its potential indirect benefit as a buffer to the Cordova EHA. This continues to provide the functional attributes necessary for the freshwater mussel community to continue to exist, reproduce, and recruit to the population.

C. Quality of Floodplain Benefits. HEC-EFM was used to derive preliminary acreages for floodplain forest and scrub-shrub/pollinator benefits (Section V, *Development and Evaluation of Alternatives*). Threshold elevations to model aquatic, scrub-shrub, and forestry acres for the Project area were developed based on growing season inundation duration and exceedance probability determined by the PDT’s best professional judgment (see Appendix M, *Engineering Design*). Time series analyses to identify the appropriate elevation threshold for each habitat type was performed using HEC-EFM. Acreages for each habitat type were then calculated based on existing conditions and with-Project terrains and elevation thresholds. Then, both the Corps-approved (per EC 1105-2-412) Yellow Warbler (Schroeder, 1982) and the Gray Squirrel (Allen, 1987) HSI models were employed to quantify the habitat benefits associated with increases in topographic diversity and bottomland forest restoration during both initial succession and forest maturation.

1. Forestry Habitat. Alternative restoration states include the area and height of topographic diversity. Topographic diversity is important because different plant communities occur within specific flood zones, and lack of physical diversity can lead to low plant community diversity, which has been seen in large rivers nation-wide. The upper limit of tree planting was identified as 576.2 feet NAVD88, which is based on the 25-percent exceedance probability for the minimally tolerant growing season inundation criteria (25-day inundation duration) and the lower limit of tree planting was identified based on the 25-percent exceedance probability for the moderately tolerant growing season inundation criteria (45-day inundation duration).

The Yellow Warbler HSI Model was used to assess pioneer floodplain forest habitat because yellow warblers prefer hydrophytic scrub-shrub habitat for foraging and nesting and are often limited in the availability of quality wet scrub-shrub habitat. For measures that only involve the planting of forestry habitat, the Yellow Warbler model was only modeled at TY 20 to represent the benefits accrued during initial succession of the floodplain forest. The following assumptions in applying the Yellow Warbler HSI model were made:

Baseline Condition. There is currently very few hard mast tree species available in the Project area. Areas that have the required elevation to support this habitat are either dominated by reed canary grass monocultures or have been eroded by increasing flood frequency and duration and higher water tables. A lack of tree regeneration, species diversity, and increased mortality characterizes the floodplain forest in the Project area.

Future Without Project Conditions. It is assumed that tree mortality and tree recruitment will continue at a rate similar to the last 30 years. Open canopy areas will continue to be degraded and likely result in reed canary grass monoculture development, especially in areas already dominated by this invasive species. For areas that currently have existing forestry habitat, it was assumed that increasing water inundation and duration and island erosion will result in a continued loss of topographic diversity.

Future With Project Conditions. Placement at these sites requires very little tree clearing (1.3 acres) and results in a significant increase in habitat benefits as areas currently dominated by reed canary grass monocultures are converted floodplain forest habitat with inclusion of hard mast tree species. Restoring island areas to optimum tree survival elevations also provides an increased buffer to backwater lakes, helping to slow down water during high flows and allow sediment to drop out prior to reaching potential overwintering habitat. TSI efforts (tree thinning treatments, tree planting, and invasive species management) would continue for the life of the Project (50 years) to further improve habitat health, diversity, and resilience of forestry sites.

The Gray Squirrel HSI Model was used to assess hard mast tree habitat because grey squirrels require diverse mast producing tree habitat for forage, cover, and reproduction, and are often limited in the availability of mast producing trees in the floodplain. The Gray Squirrel HSI was only modeled at TYs 30 and 50 to represent the amount of time it would take for tree plantings to mature and begin accruing habitat benefits. In applying the Gray Squirrel HSI model, the same assumptions were made as the Yellow Warbler HSI Model.

2. Scrub-Shrub/Pollinator Habitat. The Yellow Warbler HSI Model was used to assess pioneer floodplain forest habitat because yellow warblers prefer hydrophytic scrub-shrub habitat for foraging and nesting and are often limited in the availability of quality wet scrub-shrub habitat. For measures that only involve the planting of scrub-shrub/pollinator habitat, the yellow warbler model was used for all TYs to evaluate habitat benefits.

The upper limit for scrub-shrub/pollinator planting was identified as 573.1 feet NAVD88; this elevation is based on the 50-percent exceedance probability for maximum tolerant growing season inundation duration (55-day inundation duration). However, field observations by the Project forester support that scrub-shrub/pollinator species can thrive at higher elevations than the upper limit, so these plantings may be incorporated at higher elevations. The following assumptions in applying the Yellow Warbler HSI model were made:

Baseline Condition. There is currently very little scrub-shrub/pollinator habitat available in the Project area. Areas that have the required elevation to support this habitat are either dominated by reed canary grass monocultures or open water areas adjacent to existing scrub-shrub/pollinator habitat.

Future Without Project Conditions. Open canopy areas will continue to be degraded and likely result in reed canary grass monoculture development, especially in areas already dominated by this invasive species. For areas adjacent to existing shrub-shrub/pollinator habitat, it was assumed that sediment deposition and increasing water inundation and duration will result in a continued loss of topographic diversity.

Future With Project Conditions. Placement at these sites requires no tree clearing and removal and provides significant habitat benefits as reed canary monocultures are converted to scrub-shrub/pollinator habitat. Planting at sites near existing scrub-shrub/pollinator habitat will help to protect the existing habitat, while increasing and enhancing the habitat in that area. TSI efforts (buttonbush coppicing) would continue for the life of the Project (50 years) to further enhance the topographic diversity of scrub-shrub/pollinator habitat sites.

3. TSI Benefits Using HGM Approach. TSI measures were not included in the initial habitat analysis, but were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project area. Since TSI prescriptions were anticipated to be the same for all Final Array Project alternatives, the Hydrogeomorphic (HGM) Approach was later applied to support the TSP and demonstrate the additional benefits provided by TSI actions relative to the cost of the Project. The HGM Approach is a collection of concepts and methods for developing functional indices and using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. This approach to functional assessment estimates the change in functioning induced by alteration of a wetland, either positive or negative. Though initially designed to be used in the context of the Clean Water Act Section 404 permit reviews, the HGM Approach can also be used to determine the amount of positive effects (i.e., increases in sustainable levels of functioning) normally through restoration of previously altered wetlands of the same type. For this assessment, the PDT used the Corps-certified HGM Approach for Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley (Klimas et al., 2004), a regional guidebook which provides the models and reference data used to assess the functional capacity of the floodplain forest to:

- Detain floodwater,
- Detain precipitation,
- Cycle nutrients,
- Export organic carbon,
- Maintain plant communities, and
- Provide habitat for fish and wildlife.

Similar to the HEP format, the PDT used the HGM approach and assessment models to evaluate habitat benefits resulting from TSI implementation, which are described as Functional Capacity Index

(FCI) values (on a scale from 0.0 – 1.0). The FCI values for all functions were averaged and multiplied by area to derive net benefits (AAHUs) between the Future Without and Future With Project conditions at TY 50. The following assumptions in applying the Delta Region HGM guidebook to the Project area were made:

Baseline Condition. A lack of tree regeneration, species diversity, and increased mortality characterizes the floodplain forest in the Project area. The forest is currently dominated by over-mature even-aged silver maple stands, with limited regeneration and decreasing numbers of hard mast-producing trees. TSI prescriptions were derived from current environmental and forest conditions and focused on areas at higher risk of forest decline (approximately 900 acres).

Future Without Project Conditions. It is assumed that tree mortality and tree recruitment will continue at a rate similar to the last 30 years. Future average flood frequency and duration were also assumed to remain constant over the Project life (50 years). Without TSI implementation and successive tree recruitment, open canopy areas will continue to be degraded and likely result in reed canarygrass monoculture development. This slow progression over several decades will further increase the probability of conversion from closed-canopy forest communities to expansive acres of non-native herbaceous species. Thus, as mortality of even-aged silver maple stands increases, tree basal area (BA) and density are assumed to decrease by half from the baseline condition. These forecasted conditions for the FWOP were based on Corps' forester best professional judgment, reflecting reference stand conditions of the UMR that can reasonably be expected to occur without implementation of TSI in the Project area.

Future With Project Conditions. It is assumed that implementation of TSI will alter the long-term impacts of an overstocked forest, improving forest habitat health, diversity, and resilience in the Project area. TSI actions (tree thinning treatments, tree planting, and invasive species management) will continue for the life of the Project (50 years), gradually opening the forest canopy, providing light to understory seedlings and saplings and interspersed tree plantings, enabling recruitment of various tree ages, and reducing undesirable vegetation and competition for native species. In the short term, these alterations will help uniformly distribute needed growing space and sunlight throughout TSI areas during a single treatment window of just under 2 years, thereby reducing the risk of forest conversion to non-native species by creating favorable conditions to young tree establishment. After 50 years, the amount of growing space (BA) will increase from the baseline condition, while tree density will even out over the Project life. These forecasted conditions for the FWP were based on Corps' forester best professional judgment, reflecting reference stand conditions of the UMR that can reasonably be expected to occur following implementation of TSI in the Project area.

IV. HABITAT EVALUATION RESULTS

Section IV of the Main Report, *Potential Project Measures*, describes each potential Project measure in detail. After a lengthy process involving preliminary analysis, identification of compatibility, dependencies, and input from our resource agencies, the Project planning team identified a list of measures to be formulated into alternatives before this habitat quantification exercise (Table D-2). Table s D-3, D-4, and D-5 provide summaries of the results of the habitat benefit evaluation.

Table D-2: Combined Aquatic and Topographic Diversity Measures

Alt. 18	USI Head, Steamboat Island aquatic diversity
Alt. 19	USI Head, Steamboat Island aquatic diversity, Grant Slough Complex
Alt. 22	USI Head, Steamboat Island aquatic diversity, Flow Diversity
Alt. 23	USI Head, Steamboat Island aquatic diversity, Grant Slough Complex, Flow Diversity
Alt. 26	USI Head, Steamboat Island aquatic diversity, West SE Island
Alt. 27	USI Head, Steamboat Island aquatic diversity, SE Island, Grant Slough Complex
Alt. 30	USI Head, Steamboat Island aquatic diversity, West SE Island, Flow Diversity
Alt. 31	USI Head, Steamboat Island aquatic diversity, West SE Island, Grant Slough Complex, Flow Diversity

A. Aquatic Benefits. Tables D-3 and D-4 provide the final Suitability Index (SI), acres for each alternative, habitat units, gross AAHUs, and net AAHUs (lift) for each TY under consideration.

B. Floodplain Benefits. Tables D-5 and D-6 provide the final SI (or FCI), acres for each alternative, habitat units, gross AAHUs, and net AAHUs (lift) for each TY under consideration.

Table D-3: Aquatic Benefit Evaluation Results for Backwater Excavation Measures

				OUTPUT					
Measure	**Measure Name**	**Condition**	**Target Year**	**Bluegill SI**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Overwinter Fish Habitat	No Action-Steamboat Island Proper Complex	Existing	0	0.52	0.52	0.14	1.0	0.10	**0.0**
		FWOP	10	0.52	0.52	0	0.0		
			25	0.52	0.52	0	0.0		
			50	0.52	0.52	0	0.0		
	Steamboat Island Proper Complex	With Project	1	0.94	0.94	23	22.0	19.19	**19.1**
			10	0.87	0.87	23	21.0		
			20	0.87	0.87	23	21.0		
			30	0.87	0.87	21	19.0		
			50	0.77	0.77	19	15.0		
	No Action-Grant Slough Complex	Existing	0	0.52	0.52	0	0.0	0.00	**0.0**
		FWOP	10	0.52	0.52	0	0.0		
			25	0.52	0.52	0	0.0		
			50	0.52	0.52	0	0.0		
	Grant Slough Complex	With Project	1	0.94	0.94	6	6.0	5.94	**5.9**
			10	0.87	0.87	6	6.0		
			20	0.87	0.87	6	6.0		
			30	0.87	0.87	6	6.0		
			50	0.77	0.77	6	5.0		

Table D-4: Mussel Habitat Benefit Evaluation Results for Flow Diversity/Island Restoration Measures

				OUTPUT					
Measure	**Measure Name**	**Condition**	**Target Year**	**Walleye SI**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Mussel Habitat	No Action	Existing	0	0.30	0.30	0.4	0.1	0.10	**0.0**
		FWOP	10	0.25	0.25	0.4	0.1		
			25	0.20	0.20	0.4	0.1		
			50	0.15	0.15	0.4	0.1		
	Steamboat Slough Flow Diversity	With Project	1	0.72	0.72	0.4	0.3	0.20	**0.1**
			10	0.74	0.74	0.4	0.3		
			25	0.75	0.75	0.4	0.3		
			50	0.74	0.74	0.4	0.3		
	No Action	Existing	0	0.74	0.74	0	0.0	0.00	**0.0**
		FWOP	10	0.72	0.72	0	0.0		
			25	0.70	0.70	0	0.0		
			50	0.65	0.65	0	0.0		
	West SE Island	With Project	1	0.31	0.31	1	0.3	0.64	**0.6**
			10	0.71	0.71	1	0.7		
			25	0.70	0.70	1	0.7		
			50	0.74	0.74	1	0.7		

Table D-5: Floodplain Benefit Evaluation Results for Topographic Diversity Measures

				OUTPUT						
Measure	**Measure Name**	**Condition**	**Target Year**	**Gray Squirrel SI**	**Yellow Warbler SI**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Floodplain Forest/ Scrub-Shrub Wetlands	No Action-USI Head	Existing	0	0.00	0.00	0.00	14	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	14	0.0		
			30	0.00	0.00	0.00	14	0.0		
			50	0.00	0.00	0.00	14	0.0		
	USI Head	With Project	1	0.00	0.00	0.00	14	0.0	10.30	**10.30**
			20	0.00	1.00	1.00	14	14.0		
			30	0.91	0.00	0.91	14	12.7		
			50	0.91	0.00	0.91	14	12.7		
	No Action-Steamboat Island Proper Complex	Existing	0	0.00	0.00	0.00	14	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	14	0.0		
			30	0.00	0.00	0.00	14	0.0		
			50	0.00	0.00	0.00	14	0.0		
	Steamboat Island Proper Complex	With Project	1	0.00	0.00	0.00	14	0.0	10.30	**10.30**
			20	0.00	1.00	1.00	14	14.0		
			30	0.91	0.00	0.91	14	12.7		
			50	0.91	0.00	0.91	14	12.7		
	No Action-Grant Slough Complex	Existing	0	0.00	0.00	0.00	30	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	30	0.0		
			30	0.00	0.00	0.00	30	0.0		
			50	0.00	0.00	0.00	30	0.0		
	Grant Slough Complex	With Project	1	0.00	0.00	0.00	30	0.0	22.00	**22.00**
			20	0.00	1.00	1.00	30	30.0		
			30	0.91	0.00	0.91	30	27.2		
			50	0.91	0.00	0.91	30	27.2		
	No Action-West SE Island	Existing	0	0.00	0.00	0.00	4	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	4	0.0		
			30	0.00	0.00	0.00	4	0.0		
			50	0.00	0.00	0.00	4	0.0		

Table D-5: Floodplain Benefit Evaluation Results for Topographic Diversity Measures (continued)

Floodplain Forest/ Scrub-Shrub Wetlands	West SE Island	With Project	1	0.00	0.00	0.00	4	0.0	2.90	**2.90**
			20	0.00	1.00	1.00	4	4.0		
			30	0.91	0.00	0.91	4	3.6		
			50	0.91	0.00	0.91	4	3.6		
	No Action-Steamboat Island Proper Complex Scrub-Shrub	Existing	0	[redacted]	0.00	0.00	5	0.0	0.00	**0.00**
		FWOP	20	[redacted]	0.00	0.00	5	0.0		
			30	[redacted]	0.00	0.00	5	0.0		
			50	[redacted]	0.00	0.00	5	0.0		
	Steamboat Island Proper Complex Scrub-Shrub	With Project	1	[redacted]	0.00	0.00	5	0.0	3.90	**3.90**
			20	[redacted]	1.00	1.00	5	5.0		
			30	[redacted]	1.00	1.00	5	5.0		
			50	[redacted]	1.00	1.00	5	5.0		

Table D-6: Floodplain Benefit Evaluation Results for Timber Stand Improvement Measures

Measure	Measure Name	Condition	Target Year	HGM FCI	FCI Final	Acres	HUs	AAHUs	Net AAHUs
Timber Stand Improvement	No Action-TSI	Existing	0	0.64	0.64	900	576.0	461.00	**0.00**
		FWOP	50	0.51	0.51	900	459.0		
	TSI Prescriptions	With Project	1	0.64	0.64	900	576.0	779.00	**318.0**
			50	0.87	0.87	900	783.0		

V. COST EFFECTIVENESS/INCREMENTAL COST ANALYSES AND TENTATIVELY SELECTED PLAN DISCUSSION

The results of the habitat analysis support the premise that the functions and values of the Project can be restored by implementing one of the described cost effective alternatives or best buy plans (see Section V, *Development and Evaluation of Alternatives* for a review of CEICA and TSP selection process). The HEP analysis indicates substantial improvements in both aquatic and floodplain habitats of the Project. Overwintering habitat would be significantly improved through excavation and island protection, which greatly enhances habitat diversity through habitat complexity, protection, and growth. Floodplain habitat can certainly be improved through topographic diversity, which creates the opportunity for hardwood species to survive and grow. This in turn provides a significant improvement in food, cover, breeding, and overwintering habitat for nearly every species of wildlife residing in and/or migrating to the floodplain. Due to the acreage of the Project floodplain, it is difficult for a single Project to re-create conditions which were present prior to the 9-foot navigation channel implementation. However, the TSP would make great strides in restoring the structure and function those conditions provided.

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA, AND
ROCK ISLAND COUNTY, ILLINOIS

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APPENDIX E

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE DOCUMENTATION REPORT

I. GENERAL

A. Authority. The Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP; Project) is an ecosystem restoration project being developed through the Upper Mississippi River Restoration (UMRR) Program. The UMRR Program, authorized by the Water Resources Development Act (WRDA) of 1986 under Section 1103 and extended indefinitely by the WRDA of 1999, is a Federal/State partnership program for planning, construction and evaluation of fish and wildlife habitat rehabilitation projects and for monitoring the natural resources of the river system. It is a regional program that includes the U. S. Army Corps of Engineers' (Corps) St. Paul, Rock Island, and St. Louis Districts. The purpose of the HREPs is to preserve and restore habitat on the Mississippi and Illinois floodplain river systems.

B. Guidance and Policy. The Corps' Engineering Regulation (ER) 1105-2-100, *Planning Guidance Notebook,* provides guidance for the conduct of Civil Works Planning. The policies and authorities outlined in ER 1165-2-132, *Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects*, and ER 405-1-12, *Real Estate Handbook*, were developed to facilitate the early identification and appropriate consideration of HTRW issues in all of the various phases of a water resources study or project. Division Regulation 1165-2-132 provides divisional guidance for HTRW assessment for Civil Works projects. American Society for Testing and Materials (ASTM) Standards E1527-13 and E1528-06 provide a comprehensive guide for conducting Phase I Environmental Site Assessments (ESA). ASTM Standard E1903-97(2002) provides guidance for Phase II ESAs. These references provide information on what considerations are to be factored into project planning and implementation. The Corps' policy is to avoid construction of civil works projects when HTRW is located within project boundaries or may affect or be affected by such projects.

II. INTRODUCTION

A. Purpose and Scope. The specific purpose of an HTRW Documentation Report is to adequately document an appropriate inquiry into HTRW activities on potential project lands. The scope of this report documents the HTRW investigation for the Steamboat Island HREP Feasibility Study.

This HTRW inquiry is required in order to minimize and prevent Federal liability under the Comprehensive Environmental Response, Compensation and Liability Act and to reduce any threats to Project workers and avoid costly delays associated with environmental abatement activities.

A Phase I ESA for the Feasibility Study area was conducted by personnel from the USACE Rock Island District (District) Environmental Engineering Section (CEMVR-EC-DN). Copies of the Phase I ESA are available from CEMVR-EC-DN.

B. Limiting Conditions and Methodologies Used. The techniques used to assess HTRW contamination within and adjacent to the Project area consisted of review of historical documents, Federal and state environmental databases, aerial photographs, topographic maps, and conducting interviews and site visits. The scope of inquiry was limited to investigating onsite HTRW potential within the Project boundaries as well as offsite HTRW potential within a reasonable distance (according to ASTM standards) from the Project.

III. STUDY AREA

A. Description. The Study Area is comprised of U. S. Government-owned tracts on Steamboat Island, area along the eastern border of Princeton Refuge, two small unnamed islands southeast of Steamboat Island proper, and forested floodplain to the north and south of the mouth of the Wapsipinicon River. A portion of the northern border is delineated by 291st St., Camanche, IA, and Wendling Quarries. The Study Area covers approximately 2,620 acres consisting of woodlands, meadows, wetlands, shorelines, and open water. It is situated approximately between Mississippi River Miles 503 and 507. The entirety of the main island lies within Pool 14. The USFWS maintains Steamboat Island proper in the Study Area.

To the west of the Study Area is the Princeton Refuge, which is managed by the Iowa DNR. To the east are the navigation channel of the Mississippi River, private rural residences on the Illinois shoreline, and row crop agricultural areas. To the north is forested floodplain associated with the mouth of the Wapsipinicon River. Steamboat Island proper is surrounded by the Mississippi River, creating shorelines along the boundaries.

The Study Area is located within portions of three counties. Township 80 North, Range 5 East, Sections 11, 12, 13 and 14 in Clinton County, Iowa; Township 80 North, Range 5 East, Sections 13, 14, 23, 24, 25, 35 and 36 in Scott County, Iowa; and Township 20 North, Range 6 East, Sections 30, 31 and 36 in Rock Island County, Illinois.

Appendix E-A includes an aerial photo of the Study Area.

B. Physical Setting. The USGS topographical map from 2017 was used for records review. Surface elevation for the Study Area ranges from approximately 560 feet to 580 feet above mean sea level (NAVD 1988). The Study Area is comprised of islands formed in the Mississippi River as well as floodplain forests associated with the mouth of the Wapsipinicon River.

Surficial geology consists of Deforest Formation, Quaternary System silty clay loam and clay loams associated with the modern channel of the Wapsipinicon and Mississippi River valleys. Bedrock geology consists of Silurian Age, Hopkinton and Blanding Formation dolomites. According to the USDA NRCS Web Soil Survey, soils surrounding the Study Area consist of loamy fluvaquents with 0 to 2 percent slopes, frequently flooded.

IV. ENVIRONMENTAL SITE ASSESSMENT

A Phase I ESA was completed in the spring of 2018 for the Study Area and adjacent area. The Phase I ESA documented the Study Area history, reviewed state and Federal environmental databases, and identified potential Recognized Environmental Conditions (RECs).

A. Historical Use Information. The Study Area has been a forested island and floodplain complex since at least the 1890s. This determination is based on plat maps from the 1890s, aerial photos taken throughout the 20th Century (1930s, 1950s-2000), and into the 21st Century (2000s, 2013-2015), as well as interviews. The U.S. Government purchased the properties of the Study Area in 1940 in support of the 9-foot Navigation Channel Project on the adjacent Mississippi River. The USFWS manages the Study Area lands. The District places dredge materials from the navigation channel on the southeastern portion of the Steamboat Island bankline and also leases a cottage site in Tract 1als 8, near the center of Steamboat Island. This area is a popular destination for recreational boaters.

One potential REC, the QC Generating Station, was observed in the aerial photographs (Appendix E-B), located east of the Study Area.

No Sanborn Fire Insurance Maps were found for the Study Area or immediate surrounding properties.

B. Site Reconnaissance. Site visits were conducted by Steve Gustafson (CEMVR-EC-DN) on April 26, 2017, August 29, 2017, and December 3, 2017. A reconnaissance was performed with visual inspection of surrounding properties. The following observations were made:

- No indications of spills or staining were observed on the natural or manmade surfaces.
- No indications of hazardous materials storage areas.
- No indications of refuse or illegal dumping

C. Findings. The Phase I ESA identified one potential REC in or near the Study Area:

- QC Generating Station was identified within a 1-mile radius. The QC Generating Station is considered a small quantity generator of hazardous waste and a permitted discharger of wastewater (chlorine, elevated temperature water, zinc, boron, total suspended solids, oil and grease).

V. CONCLUSIONS

There are no Controlled RECs or Historic RECs present in the Study Area. The potential REC of the QC Generating Station is considered de minimus. Further research into NPDES discharge data associated with the facility did not indicate any HTRW concerns, and the only potential impact from the facility is considered thermal, which is not an HTRW concern. The substances permitted for discharge are not of the magnitude to warrant HTRW concerns on the proposed Project areas. Therefore, there are no RECs associated with the Study Area.

VI. RECOMMENDATIONS

No further HTRW assessment is recommended.

VII. LIMITATIONS

No ESA can wholly eliminate uncertainty regarding the existence for recognized environmental conditions concerning a property. This assessment is intended to reduce, but not eliminate, uncertainty regarding the existence of recognized environmental conditions in connection with a property with reasonable limits of time and cost. If any previously unaddressed recognized environmental condition should arise, this HTRW Documentation Report will be revisited. Title searches and research into environmental liens were not conducted for this report, but will be required prior to construction phase of the preferred alternative.

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

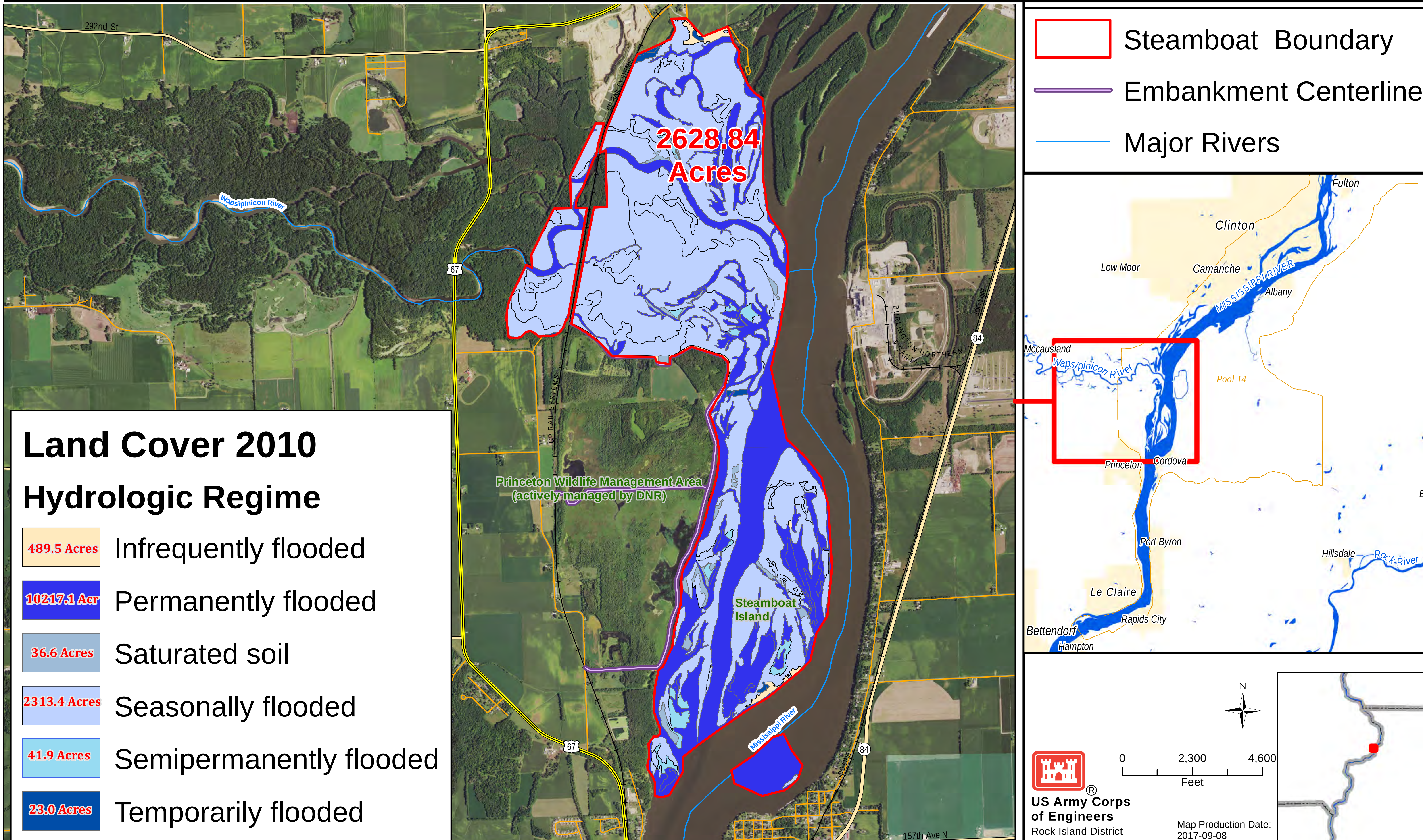
STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX E-A

STUDY AREA

Steamboat HREP-Hydrologic Regime



UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX E-B

HISTORICAL AERIAL PHOTOGRAPHS

Steamboat HREP- Aerial 2015

Steamboat HREP- NAIP Aerial 2010

Steamboat HREP- Aerial 2005 Scott County

Legend

Project Boundary

River Miles

US Army Corps of Engineers
Rock Island District

N

0 1,250 2,500
Feet

Map Production Date:
2017-03-09

Location Map

Steamboat HREP- Aerial 1990s

Steamboat HREP- Aerial 1980s CIR

Steamboat HREP- Aerial 1970s

Legend

Project Boundary

River Miles

US Army Corps of Engineers
Rock Island District

N

0 1,250 2,500
Feet

Map Production Date:
2017-03-10

Location Map

Steamboat HREP- Aerial 1960s

Steamboat HREP- Aerial 1950s

Legend

Project Boundary

River Miles

US Army Corps of Engineers
Rock Island District

N

0 1,250 2,500
Feet

Map Production Date:
2017-03-10

Location Map

Steamboat HREP- Aerial 1930s

Steamboat HREP- Aerial 1927 Mississippi River

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POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
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APPENDIX F

WATER QUALITY

UPPER MISSISSIPPI RIVER RESTORATION
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STEAMBOAT ISLAND
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APPENDIX F

WATER QUALITY

TABLES

FIGURES

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
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STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX F

WATER QUALITY

I. PURPOSE

The purpose of this appendix is to evaluate the results from water quality monitoring performed by Rock Island District (District) personnel at potential environmental enhancement sites located within the *Steamboat Island Habitat Rehabilitation and Enhancement Project* (Project). Water quality monitoring was performed with the primary objective of defining pre-Project baseline water quality conditions.

II. INTRODUCTION

Baseline water quality monitoring was initiated in order to determine pre-Project conditions and assist with selecting and locating measures and/or alternatives for habitat rehabilitation and enhancement. This monitoring also supports future evaluation of the Project related to the goal of restoring and protecting off-channel aquatic and wetland habitat. Of particular importance is an increase in aquatic habitat diversity and providing the water quality characteristics critical for overwintering fish. The District initiated baseline water quality monitoring at the Project on December 19, 2014, at site W-M504.7S (Figure F-1).

Sites W-M504.9P, W-M505.7C, and W-M505.0B were added on June 6, 2017, and site W-M504.1E on December 8, 2017. Baseline monitoring continued through March 11, 2019, with eight samples collected during the summer months and two or three samples during the winter months each full year. Site W-M504.7S was initially chosen as a representative pre-Project monitoring location because the Project fact sheet identified the Upper and Lower Lakes of Steamboat Island as likely areas to restore overwintering habitat. A site in Lower Lake (W-M503.6L) was identified but not sampled due to inadequate water depth. During the feasibility phase, site W-M504.9P was added to observe the differences between an isolated portion of the upper interior lake and the area affected by inflow from the main channel via the breached northeast bank of Steamboat Island. Aquatic vegetation has been observed near both sites, with coontail being the dominant species at site W-M504.7S and lotus at site W-M504.9P, the more heavily vegetated of the two sites. NW Grant Slough Lake was also a proposed overwintering habitat location (site W-M504.1E). This site was identified during the feasibility phase and lotus and coontail have been identified there.

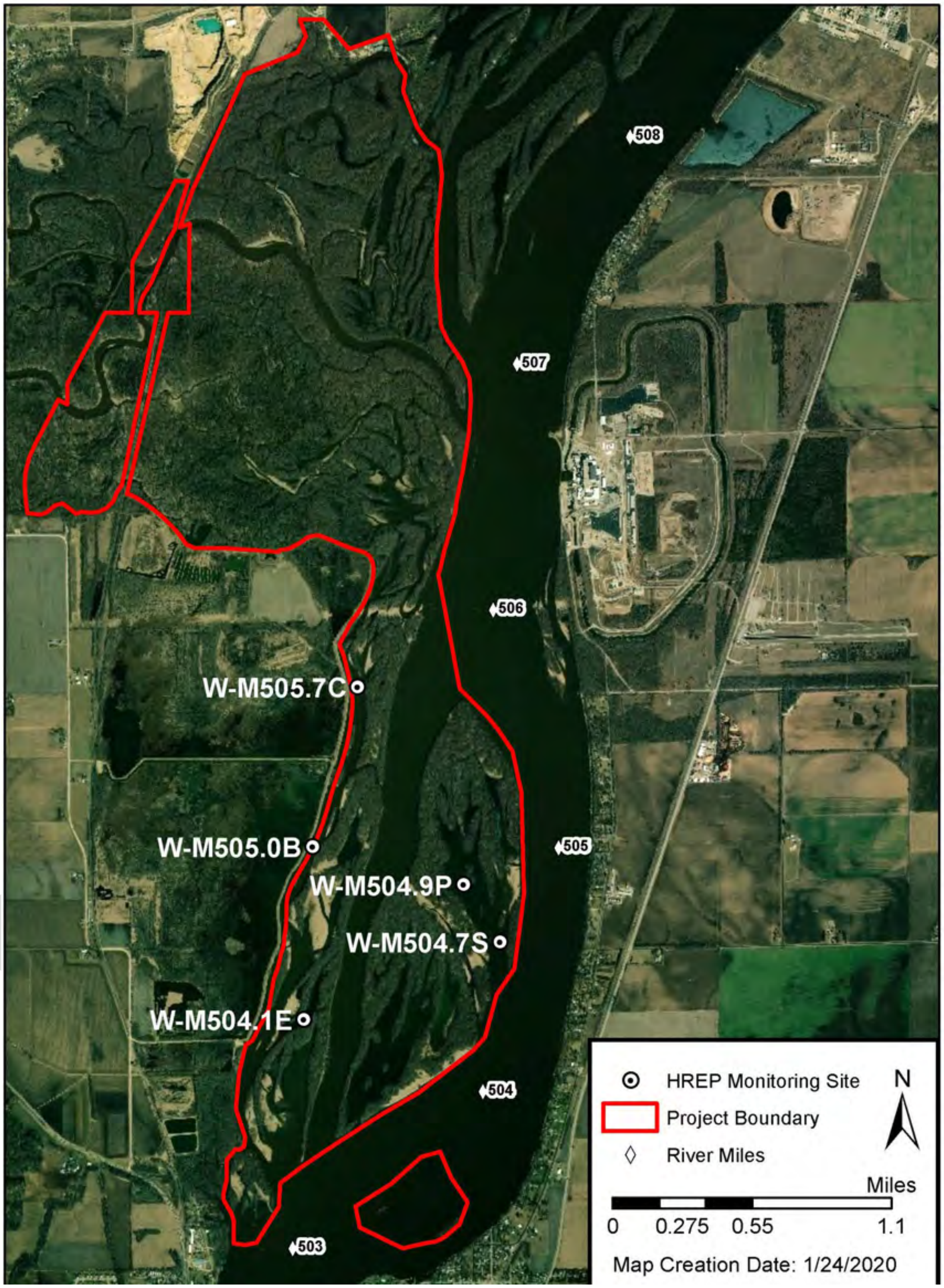

Figure F-1: Project Water Quality Monitoring Locations

Sites W-M505.7C and W-M505.0B are located in Grant Slough, above and below, respectively, a cut-through channel that flows from Steamboat Slough into Grant Slough. The purpose of these sites was to observe differences in water quality in Grant Slough caused by flow coming in from a bisecting channel and to provide information related to the potential placement of a sediment closure structure within the Project to reduce sediment input. These two sites are deeper, have greater water velocities, and little aquatic vegetation relative to the other three sampling sites.

III. METHODS

Baseline water quality monitoring was accomplished through a combination of collecting grab (discrete) water samples and deploying continuous monitors (sondes). Eight grab samples were collected during the summer months, and two or three grab samples were collected during the winter months at each site, each year. In general, sampling date, time, water depth, water transparency via Secchi disk depth, water velocity, wave height, air temperature, percent cloud cover, wind speed and direction, pH, water temperature, DO, and specific conductance were recorded in the field. During the summer months, a water sample was collected just below the surface at each sampling site. The sample was placed on ice and shipped to ARDL, Inc., Mt. Vernon, Illinois for total suspended solids (TSS) and chlorophyll analyses. Water grab samples were collected for turbidity as measured in Nephelometric Turbidity Units (NTU)[1] and alkalinity analyses, which were performed in-house. Sample collection/preservation and field/laboratory analytical procedures were performed according to USEPA approved methods. In addition to the manually collected data, YSI 6600 or EXO2 multi-parameter water quality sondes were deployed on numerous occasions. Typically, the sondes were suspended 1 to 2 feet from the river bottom and were programmed to record the following data every 2 hours: DO, pH, water temperature, depth, specific conductance, and turbidity as measured in Formazin Nephelometric Units (FNU)[1] (primarily since 2016). The 2-hour frequency gives sufficient resolution to the data and conserves sonde battery life and recorder storage space. Summer deployments typically lasted 2 to 4 weeks, while in the winter the sondes were deployed for approximately 6 to 14 weeks.

IV. RESULTS AND DISCUSSION

In general, sites W-M504.7S, W-M504.9P and W-M504.1E exhibit more lake-like (lentic) characteristics than the more riverine (lotic) sites W-M505.0B and W-M505.7C. The lentic sites typically exhibit lower water velocities, and have better water clarity as reflected in measurements of Secchi disk depth, turbidity and total suspended solids. These differences, along with others, are described below in detail for each of the five Project water quality monitoring sites. Minimum, maximum, average and median statistics for several parameters at each site are displayed for the summer and winter seasons in Table F-1.

A. Site W-M504.7S. Table F-2 shows the results from surface grab sample monitoring at site W-M504.7S. This site had the longest period of record, covering five winter and four summer

[1] Due to differences in sensor type, sonde turbidity readings are reported in FNU and turbidity grab samples analyzed with a turbidimeter are reported in NTU. For the purposes of this evaluation, it was assumed that 1FNU = 1 NTU.

sampling seasons. DO concentrations below the target level of 5 mg/L were observed during each summer season, with at least half of the readings during the summers of 2017 and 2018 falling below the target level.

Winter grab sample DO concentrations at site W-M504.7S never fell below the target level during the five seasons monitored. The lowest DO concentration observed was 7.94 mg/L on February 3, 2015. Approximately half of the values were supersaturated. The median water temperature was 1.7°C and the lowest value was 0.1°C. Velocities ranged from 0.24 cm/sec to 2.82 cm/sec with a median of 0.77 cm/sec.

A sonde was deployed at site W-M504.7S on every sampling trip. Figure F-2 shows results from the 2015 summer season. Figure 2 also shows grab samples collected with handheld instruments to validate sonde readings. DO and temperature were measured at the depth of the sonde, but due to the limitations of the field pH meter used, pH was only measured at the surface. It was common to see DO concentrations fall below the target level concentration of 5 mg/L during the night, but they always recovered the following day. DO concentrations regularly reached supersaturated levels during daytime hours. The diurnal DO concentration swing was typically 5-6 mg/L, but at times exceeded 10 mg/L. The summers of 2017 and 2018 were similar to 2015 in that it was common to see nighttime concentrations below 5 mg/L but there were no extended periods of continuous low DO. This was not true, however, during the summer of 2016, when most DO concentrations were below 5 mg/L, including a continuous period from July 22 to August 19 (Figure F-3). Water clarity and chlorophyll values during this period suggest a lack of photosynthetic activity was the likely cause for the low DO concentrations. The low concentrations were confirmed by handheld meter readings at the depth of the sonde of 2.16 mg/L on August 2, 2016 and 0.84 mg/L on August 16, 2016. Surface grab sample DO concentrations were also below 5 mg/L on these dates; thus, indicating low DO throughout the water column.

DO concentrations measured by sonde during the winter at site W-M504.7S also never fell below the target level during the five monitoring seasons. The lowest DO concentration observed was 5.20 mg/L on December 12, 2018 (Figure F-4). This figure is reflective of the remaining four winter seasons monitored in that no DO concentrations were below 5 mg/L and approximately half of the values were supersaturated. The average sonde-measured water temperatures for the five winter seasons were (beginning with the 2014-2015 season): 1.42, 3.46, 1.72, 2.09 and 2.11°C, respectively.

B. Site W-M504.9P. Site W-M504.9P was monitored for two winter and two summer seasons. Table 3 shows the results from grab sample monitoring at site W-M504.9P. This site is the most isolated from the effects of the main channel and is the most heavily vegetated site (primarily lotus). This likely contributed to the minimum (0.82 mg/L on July 18, 2017) and maximum (23.22 mg/L on January 31, 2018) DO concentrations of all sites occurring here. Seven DO concentrations at this site were below 5 mg/L, all occurring during the summer months. Six consecutive grab sample DO concentrations collected from July 5, 2017, through September 12, 2017, were below 5 mg/L. The isolated nature of this site was also shown in measurements reflective of water clarity—Secchi disk depth, turbidity and total suspended solids. The summer median value for Secchi disk depth (69.3 cm) was the highest of all five sites, while turbidity (11.0 NTU) and total suspended solids (9.7 mg/L) median values were the lowest. The maximum Secchi disk depth here was an exceptional 145.0 cm, which was equal to the water depth, on July 5, 2017.

The lowest winter grab sample DO concentration was 5.27 mg/L on November 30, 2018. Median velocities here were the lowest of the five sites at 0.38 cm/sec, while the maximum winter velocity here was 0.90 cm/sec. The median winter water temperature here was the warmest of the sites (tied with site W-M504.1E) at 2.9°C.

Sondes were deployed at Site W-M504.9P during the summers of 2017 and 2018. The low grab sample DO concentrations measured for an extended period during the summer of 2017 were mirrored by the sonde monitoring results as shown in Figure F-5. Except for a few readings, DO concentrations were below 5 mg/L from June 28, 2017, through September 12, 2017. During the summer of 2018, DO concentrations were considerably higher at this site (Figure F-6). Lower water velocities (less mixing), water temperatures (lower rates of photosynthesis) and chlorophyll a concentrations (fewer photosynthetic organisms) likely all contributed to the extended low DO concentrations observed during the summer of 2017. Another factor to consider at site W-M 504.9P is the predominance of lotus here. Although water clarity at this site was relatively good (median Secchi disk depth value of 65.0 cm versus 34.0 cm at site W-M504.7S), shading caused by the large areal coverage of floating lotus leaves inhibited algal photosynthesis. Of note during the summer of 2018 was the shifting of the sonde from its initially deployed position to a location approximately 200 meters downstream (where it was found floating on the surface on September 27, 2018). The sonde was apparently removed from its weight and snag line by someone and left to drift. A sudden change in depth measured by the sonde on August 19, 2018, suggests this is likely when the sonde was disturbed.

Sondes were deployed during the winters of 2017-2018 and 2018-2019 at site W-M504.9P, with results shown in Figures F-7 and F-8, respectively. DO concentrations were supersaturated approximately half the time during the winter of 2017-2018 and significantly less during the winter of 2018-2019. DO concentrations below 5 mg/L occurred only during parts of two brief periods over the winter of 2017-2018 (January 10-11, 2018 and February 14-16, 2018); whereas, low DO concentrations occurred during three extended periods over the winter of 2018-2019 (November 30-December 16, 2018; January 29-February 8, 2019; and February 14-25, 2019). Lower median water velocities during the winter of 2018-2019 (0.26 cm/sec vs. 0.66 cm/sec in winter of 2017-2018) may have contributed to the differences in DO concentrations between the two monitoring periods. Average winter sonde-measured water temperatures were 3.74°C in 2017-2018 and 3.56°C in 2018-2019, which were warmer than those at site W-M504.7S (2.09 and 2.11°C, respectively). Readings below 3°C were 14.9% in 2017-2018 and 37.0% in 2018-2019.

C. Site W-M504.1E. The last site to exhibit lentic characteristics is W-M504.1E. This site had the shortest monitoring period, commencing on December 28, 2017. Table F-4 displays the results from grab sample monitoring which occurred here. This site is located off Grant Slough and visual observations suggest it is intermediate in the amount of aquatic vegetation relative to sites W-M504.7S and W-M504.9P. Two grab sample DO concentrations measured here were below the target level concentration: 4.58 mg/L on August 14, 2018 and 4.98 mg/L on

November 30, 2018. For the two winter seasons that were monitored here, median water velocity was 0.51 cm/sec and median water temperature 2.9°C. In general, this site was intermediate in water quality characteristics when compared to sites W-M504.7S and W-M504.9P. Sondes were not deployed at this site.

D. Sites W-M505.7C and W-M505.0B. The last two sampling locations exhibited lotic characteristics and are discussed together due to data similarities. The sites are located in Grant Slough, at points approximately equidistant up- and downstream from a bisecting channel that flows from Steamboat Slough into Grant Slough. These sites were monitored primarily to provide information related to the potential placement of a sediment closure structure within the Project to reduce sediment input. Both sites have the same period of record, commencing on June 6, 2017, and extending for two summer and two winter monitoring seasons. Grab sample results for the two sites are shown in Tables F-5 and F-6. Only one DO concentration at the two sites was below 5 mg/L: 4.95 mg/L on June 19, 2018 at site W-M505.7C. On the same sampling day, the DO concentration at site W-M505.0B was slightly higher, at 5.30 mg/L. Median water velocities at the two sites were relatively high at 19.36 and 23.39 cm/sec, respectively. Median winter water temperatures (1.2 and 1.4°C, respectively) were somewhat lower than the three lentic sites (1.7, 2.9 and 2.9°C); while median summer chlorophyll a concentrations (57.3 and 55.6 mg/m^3, respectively) were considerably higher (14.0, 26.0 and 18.3 mg/m^3).

Parameters reflective of water clarity also confirmed the lotic nature of these two sites. Median summer turbidity (41.0 and 44.9 NTU, respectively) and total suspended solids (50.2 and 69.8 mg/L, respectively) were higher than the three lentic sites (18.1, 40.4 and 11.0 NTU; and 18.4, 40.4 and 9.7 mg/L), while Secchi disk depth values were lower (31.0 and 27.5, respectively, versus 44.8, 31.3 and 69.3 cm). Additional discussion of water clarity related parameters is found below in Section E. Sondes were not deployed at sites W-M505.7C and W-M505.0B.

E. Light-Related Criteria Necessary to Support Submersed Aquatic Vegetation. Light-related criteria necessary to support and sustain submersed aquatic vegetation (SAV) during the growing season in the UMR include a Secchi disk depth of 50 cm, a TSS concentration of 25 mg/L, and a turbidity of 20 NTU, as described in UMRCC (2003). Figures F-9, F-10, and F-11 are box plots of the Secchi disk depths, TSS concentrations, and turbidity measurements for all five sites during the summer months compared to the UMRCC criteria. The percentage of water clarity measurements during the 2015-2018 growing seasons at site W-M504.7S that met the criteria were as follows: Secchi disk depth (21.9%), TSS (37.5%) and turbidity (25%). Site W-M504.9P was sampled during the growing seasons of 2017 and 2018. This site is more isolated from the effects of the main channel and it was reflected in the water clarity results which showed higher percentages of readings meeting the criteria: Secchi disk depth (81.3%), TSS (100%) and turbidity (93.8%). Site W-M504.1E showed intermediate results compared to the preceding two sites. As expected, the two lotic sites, W-M505.7C and W-M505.0B, had the most diminished water clarity. Results at these two sites were identical in that none of the Secchi disk depth, TSS or turbidity grab sample results met the criteria necessary to support and sustain SAV during the growing season. In addition to grab samples, Figure F-11 also included sonde-measured results for sites W-M504.7S and W-M504.9P. These results indicate the sondes were more effective at capturing high turbidity events; whereas, with grab samples only, these events would have been missed. The maximum sonde-measured turbidity values at sites W-M504.7S and W-M504.9P were 1682.95 and 349.31 FNU, respectively, while the maximum grab sample values were only 144 and 33.5 NTU.

V. CONCLUSION

Pre-Project baseline water quality monitoring was initiated at five Project sites: W-M504.7S (December 19, 2014), three sites on June 6, 2017 (W-M504.9P, W-M505.7C and W-M505.0B) and W-M504.1E (December 8, 2017). Monitoring continued at all sites through March 11, 2019. Monitoring was accomplished through the collection of discrete grab samples, as well as by utilization of continuous monitors (at sites W-M504.7S and W-M504.9P only).

Sites W-M504.7S, W-M504.9P and W-M504.1E exhibited lentic water quality characteristics, while sites W-M505.0B and W-M505.7C exhibited lotic characteristics. The lentic sites typically had lower water velocities, and better water clarity as reflected in measurements of Secchi disk depth, turbidity and total suspended solids. A grab sample DO concentration below the target level of 5 mg/L occurred only once at the lotic sites, while at the lentic sites, numerous low concentrations were measured, nearly all during the summer sampling season.

Sonde-measured DO concentrations at sites W-M504.7S and W-M504.9P varied by year and season. It was rare to see a winter DO concentration below 5 mg/L at either site (in fact, supersaturated values were common), except for W-M504.9P during the winter of 2018-2019, when there were three extended periods of continuous low DO. This was attributed to the lower water velocities experienced during this winter season. Increasing water depth via dredging would help alleviate the low DO concentrations here by providing a larger volume of DO in the water column prior to ice-over. Introduction of flow would also help but at the expense of increasing the sediment load and velocities. Sonde-measured winter water temperatures were generally above 3°C at site W-M504.9P, but not so at site W-M504.7S. Dredging would create deep-water habitat that would likely stratify and have water temperatures close to 4°C near the bottom.

While it was common for sonde-measured summer nighttime DO concentrations to fall below 5 mg/L at the two sites and recover the following day, there were also extended periods of low DO, lasting nearly all of the summer season at site W-M504.7S during 2016 and site W-M504.9P during 2017. Lower chlorophyll a values during these periods suggest a lack of photosynthetic activity, among other factors, contributed to the low DO concentrations. Supersaturated DO values were also common during the summer and were often accompanied by wide diurnal swings in concentration. Introduction of flow to these two sites during the growing season could help increase DO concentrations but, again, would also introduce sediment and decrease water clarity.

Only site W-M504.9P currently exhibits the light-related characteristics conducive to SAV growth. With dredging, the lentic sites W-M504.7S and W-M504.1E would likely show improvements in light related water quality characteristics. Further isolation of site W-M504.7S from main channel flows by restoring the bank line upstream of the site would also likely improve light related water quality characteristics in that part of the backwater.

The current TSP includes aquatic diversity dredging for Steamboat Island's Lower Lake in the vicinity of site W-M503.6L. Although representative monitoring could not be performed at this site because it was too shallow, Google Earth images over time indicate this site contains more aquatic vegetation than the sites that were monitored. The increased vegetation here would result in a high oxygen demand when plants senesce and bacterial decomposition occurs. This, coupled with the shallow water depth, could potentially result in extended periods of low DO at this site during the winter months; thus, making it a prime candidate for aquatic diversity enhancement via dredging.

VI. REFERENCE

Upper Mississippi River Conservation Committee (UMRCC). (2003). *Proposed Light-Related Water Quality Criteria Necessary to Sustain Submersed Aquatic Vegetation in the Upper Mississippi River.*

Appendix F
Water Quality

Table F-1: Seasonal Summary Statistics for Five Monitoring Sites

Site	Water Depth (m)	Velocity (cm/sec)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm) [1]	Turbidity (NTU)	Total Suspended Solids (mg/L) [2]	Chlorophyll a (mg/m3)[3]
W-M504.1E Summer									
Min.	0.560	0.49	19.3	4.58	7.79	25.0	9.8	9.8	12.4
Max.	1.810	18.21	28.0	11.64	8.56	55.0	33.1	32.0	80.5
Avg.	0.993	3.44	25.0	7.14	-	41.8	19.8	18.8	30.8
Median	0.948	1.47	26.0	6.23	8.12	44.8	18.1	18.4	18.3
W-M504.1E Winter									
Min.	0.520	0.22	1.9	4.98	7.37	-	7.6	-	-
Max.	0.785	0.71	4.7	20.46	8.12	-	195.0	-	-
Avg.	0.633	0.49	3.0	12.96	-	-	44.7	-	-
Median	0.610	0.51	2.9	11.75	7.86	-	13.3	-	-
W-M504.7S Summer									
Min.	0.630	0.01	19.0	1.09	7.27	12.0	5.3	4.7	<1.0
Max.	2.020	26.52	28.1	8.91	8.89	>101.5	144.0	119.0	66.0
Avg.	1.135	4.97	24.1	5.34	-	36.7	45.6	41.5	16.5
Median	1.085	3.93	24.6	5.69	7.86	31.3	40.4	40.4	12.8
W-M504.7S Winter									
Min.	0.620	0.24	0.1	7.94	7.12	-	4.2	-	-
Max.	1.040	2.82	11.3	19.03	8.72	-	53.4	-	-
Avg.	0.786	1.09	2.6	13.94	-	-	18.4	-	-
Median	0.760	0.77	1.7	13.59	7.95	-	13.0	-	-
W-M504.9P Summer									
Min.	0.960	0.02	16.8	0.82	7.24	43.0	2.4	2.6	4.9
Max.	2.325	4.80	28.1	11.26	8.58	>145	33.5	19.0	148
Avg.	1.439	0.99	23.7	4.85	-	77.3	11.0	9.4	33.9
Median	1.420	0.64	23.9	5.31	7.81	69.3	11.0	9.7	26.0

[1] Winter Secchi disk depth measurements are collected only when there is no ice cover. Due to limited data points, summary statistics are not provided for the winter season; however, all collected Secchi disk depth measurements are

[2] Total suspended solids and chlorophyll samples are not collected during the winter months.

Table F-1: Seasonal Summary Statistics for Five Monitoring Sites

Site	Water Depth (m)	Velocity (cm/sec)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm) [1]	Turbidity (NTU)	Total Suspended Solids (mg/L) [2]	Chlorophyll a (mg/m3)[3]
W-M504.9P Winter									
Min.	0.970	0.13	0.4	5.27	7.30	-	5.1	-	-
Max.	1.165	0.90	5.2	23.22	8.39	-	17.4	-	-
Avg.	1.051	0.46	2.8	13.76	-	-	11.9	-	-
Median	1.028	0.38	2.9	12.37	8.08	-	12.6	-	-
W-M505.0B Summer									
Min.	2.480	2.57	19.1	5.30	7.62	19.1	25.8	36.0	4.7
Max.	4.090	77.00	27.7	9.30	8.63	44.5	69.7	81.0	210
Avg.	3.058	35.40	24.4	7.33	-	30.6	41.4	55.0	65.3
Median	2.975	34.35	24.6	7.37	8.13	31.0	41.0	50.2	55.6
W-M505.0B Winter									
Min.	2.630	14.44	0.6	12.00	7.57	-	9.3	-	-
Max.	2.810	20.99	2.3	14.12	8.32	-	159	-	-
Avg.	2.720	16.96	1.4	12.90	-	-	42.5	-	-
Median	2.738	16.65	1.4	12.72	7.80	-	20.3	-	-
W-M505.7C Summer									
Min.	0.820	2.56	19.0	4.95	7.54	16.5	30.1	39.0	4.8
Max.	3.230	85.20	27.7	9.23	8.52	39.0	104	126	215
Avg.	1.445	33.83	24.0	7.07	-	26.8	53.6	76.8	68.7
Median	1.330	30.66	24.2	7.00	8.09	27.5	50.4	69.8	57.3
W-M505.7C Winter									
Min.	0.780	13.65	0.3	11.80	7.55	-	8.9	-	-
Max.	1.215	19.72	2.1	14.09	8.34	-	174.0	-	-
Avg.	0.979	17.13	1.2	12.84	-	-	45.4	-	-
Median	0.975	17.65	1.2	12.69	7.85	-	19.1	-	-

[1] Winter Secchi disk depth measurements are collected only when there is no ice cover. Due to limited data points, summary statistics are not provided for the winter season; however, all collected Secchi disk depth measurements are

[2] Total suspended solids and chlorophyll samples are not collected during the winter months.

Table F-2: Water Quality Monitoring Results from Samples Collected at Site W-M504.7S

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
12/19/2014	0.930	0.90	1.8	15.58	8.39	-	18.3	-	-	-	-	-
2/3/2015	0.710	0.46	0.5	7.94	7.72	-	11.4	-	-	-	-	-
3/10/2015	0.690	0.36	1.0	19.03	8.40	-	53.4	-	-	-	-	-
6/2/2015	1.300	2.17	20.3	6.13	7.67	39.5	21.2	27.5	1.2	<1.0	9.7	<1.0
6/16/2015	1.750	-	23.0	5.71	7.54	19.5	68.9	112	<1.0	<1.0	3.1	<1.0
6/30/2015	1.090	-	22.7	5.45	7.68	28	33.6	34	<1.0	2.3	3.3	<2.0
7/14/2015	0.960	-	25.7	7.31	8.30	37	12.6	13.8	1.7	3.5	2.9	<1.0
7/28/2015	0.850	-	26.7	3.92	7.94	50	20.2	14.8	<1.0	1.8	3.2	<1.0
8/11/2015	0.845	-	24.7	8.69	8.89	36	25.2	22.1	10.1	18.6	10.7	<1.0
8/25/2015	0.830	-	21.0	7.95	8.53	38	31.7	35.2	5.6	10.7	8.4	<1.0
9/9/2015	0.770	7.02	24.5	5.67	8.37	66	12.3	14.3	3.6	6.1	6.2	<1.0
1/8/2016	0.800	-	2.8	13.04	7.12	-	5.29	-	-	-	-	-
3/9/2016	1.000	2.82	11.3	15.62	8.72	34.0	23.2	-	-	-	-	-
6/7/2016	1.090	1.97	21.5	2.96	7.86	18.0	67.6	56	22.4	1.6	2.3	12.7
6/21/2016	1.250	3.94	25.3	3.49	7.64	24.4	56.1	41	11.7	1.9	3.1	8.5
7/6/2016	1.085	0.95	25.0	5.39	7.77	39.5	22.4	20	13.7	<1.0	<1.0	4.3
7/19/2016	0.875	1.73	25.7	1.09	7.40	>87.5	5.41	5.8	8.4	<1.0	<1.0	2.6
8/2/2016	1.415	6.43	25.7	3.43	7.41	73.0	11.9	8.3	5.9	<1.0	<1.0	1.5
8/16/2016	1.015	0.44	24.5	1.12	7.27	>101.5	5.32	4.7	10.9	<1.0	<1.0	<1.0
8/30/2016	1.820	8.64	23.7	5.46	7.61	23.0	46.1	36.5	7.7	<1.0	<1.0	3.8
9/13/2016	1.500	2.78	21.9	5.81	7.84	43.0	24.9	15	7.3	<1.0	<1.0	2
12/21/2016	0.760	0.42	0.5	14.53	8.07	-	4.15	-	-	-	-	-
1/30/2017	1.040	2.58	0.1	12.78	7.83	-	8.78	-	-	-	-	-
2/22/2017	0.945	0.75	7.2	14.82	8.25	>94.5	8.67	-	-	-	-	-
6/6/2017	1.850	11.84	22.0	8.91	8.17	38.0	35.9	50	52.4	2	5.9	15
6/20/2017	1.320	6.76	25.1	6.73	8.05	30.5	49.5	47.6	25.5	<1.0	1.4	11.4
7/5/2017	1.170	4.00	25.0	6.63	7.99	21.0	58.1	55.5	23.7	<1	1.6	8.4
7/18/2017	0.920	0.01	24.3	4.18	7.80	19.0	79.9	65.6	13.9	<1	1.7	8.4
8/1/2017	1.085	1.01	24.8	5.91	7.77	23.5	52.9	46.8	23.7	<1.0	1.6	4
8/15/2017	0.730	5.87	23.3	4.12	8.09	16.5	77.9	65.6	66	<1.00	6.7	8
8/29/2017	0.790	0.87	20.1	3.22	7.61	18.0	74.3	65.5	15.5	<1.0	<1.0	5.4
9/12/2017	0.705	0.51	19.0	3.65	7.79	16.0	83.3	65.3	18	2.7	3.8	<1.0
12/8/2017	0.620	1.53	3.1	18.21	8.56	-	14.6	-	-	-	-	-
1/31/2018	0.630	0.77	1.5	14.13	7.91	-	20.2	-	-	-	-	-
3/8/2018	0.665	0.72	0.9	12.87	7.98	55.0	15.3	-	-	-	-	-
6/5/2018	0.940	3.92	23.3	6.99	8.38	32.0	44.8	47.5	37.4	<1.00	1.3	15.9
6/19/2018	1.130	5.31	27.6	6.22	8.12	29.0	54.5	49.5	36.3	3	<1.0	7.2

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7/5/2018	2.020	26.52	28.1	6.24	-	43.5	18.3	21.8	14.1	<1.00	<1.00	5.6
7/17/2018	1.440	11.62	27.8	6.49	8.49	53.0	16.5	19.5	11.8	<1.00	<1.00	3.1
7/31/2018	1.025	4.83	25.5	8.59	8.41	62.0	18.8	20.8	25.6	<1.00	<1.00	2.6
8/14/2018	0.630	0.80	26.4	2.07	7.73	20.0	80.3	61.5	25	2.8	<1.00	11.4
8/28/2018	0.690	1.37	25.2	4.73	7.95	12.0	144	119	21.3	<1.00	<1.00	95.4
9/24/2018	1.420	7.86	20.4	6.58	7.88	17.0	89.9	67.5	4.6	<1.0	<1.0	<1.0
11/30/2018	0.800	1.58	2.3	12.09	7.73	-	10.7	-	-	-	-	-
2/14/2019	0.660	0.24	1.6	11.71	7.42	-	9.89	-	-	-	-	-
3/11/2019	0.760	1.08	2.2	12.83	7.79	-	53.2	-	-	-	-	-
MIN.	**0.620**	**0.01**	**0.1**	**1.09**	**7.12**	**12.0**	**4.15**	**4.7**	**<1.0**	**<0.1**	**<1.0**	**<1.0**
MAX.	**2.020**	**26.52**	**28.1**	**19.03**	**8.89**	**101.5**	**144.0**	**119.0**	**66.0**	**18.6**	**10.7**	**95.4**
AVG.	**1.029**	**3.68**	**17.5**	**7.96**	**-**	**38.8**	**37.0**	**41.6**	**16.5**	**2.1**	**2.6**	**7.6**
MEDIAN	**0.943**	**1.73**	**22.9**	**6.54**	**7.88**	**34.0**	**24.1**	**38.8**	**12.8**	**<0.1**	**1.5**	**3.5**

Table F-3: Water Quality Monitoring Results from Samples Collected at Site W-M504.9P

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
6/6/2017	2.090	1.17	20.9	6.36	7.81	65.0	12.6	10.3	27.1	<1	2.4	10.4
6/20/2017	1.570	0.28	24.7	5.26	7.90	69.0	12.5	11.5	24.8	<1.0	<1.0	7.2
7/5/2017	1.450	0.29	23.9	3.89	7.55	>145.0	2.4	<2.9	13.5	<1	<1	1.2
7/18/2017	1.260	0.02	23.8	0.82	7.47	115.0	4.88	4.4	4.9	<1	1.7	<1.0
8/1/2017	1.460	0.71	23.9	1.23	7.24	126.0	4.77	4.0	27.2	<1	1.8	3.6
8/15/2017	1.070	0.32	21.6	1.61	7.49	88.0	4.01	4.79	25.4	2.6	<1.00	2.6
8/29/2017	1.110	0.31	19.5	1.04	7.40	75.0	2.46	2.6	6.6	<1.0	<1.0	1.8
9/12/2017	1.080	0.57	16.8	1.25	7.46	91.0	6.7	5.6	19.7	<1.0	<1.0	3.7
12/8/2017	1.000	0.84	2.9	11.56	8.04	-	16.1	-	-	-	-	-
1/31/2018	0.970	0.25	5.2	23.22	8.39	-	7.93	-	-	-	-	-
3/8/2018	1.025	0.90	2.8	13.18	8.11	55.0	17.4	-	-	-	-	-
6/5/2018	1.270	1.53	23.3	8.33	8.19	51.0	15.5	19.0	88.5	12.3	2.2	27.9
6/19/2018	1.450	0.47	28.0	11.26	8.58	43.0	14.9	18.8	148	19.5	7.2	16.6
7/5/2018	2.325	4.80	28.1	5.58	-	77.0	9.4	9.6	13.7	<1.00	<1.00	2.5
7/17/2018	1.765	1.07	26.7	6.35	8.25	62.5	13	9.71	26.5	<1.00	<1.00	8.3
7/31/2018	1.390	1.05	24.1	7.59	8.11	69.5	9.35	7.6	28.5	<1.00	<1.00	6
8/14/2018	0.960	0.32	27.5	4.61	7.91	49.5	17.6	15.6	36.9	<1.00	<1.00	5.1
8/28/2018	1.010	0.73	25.7	7.07	8.31	61.0	13.2	10.5	44.8	<1.00	<1.00	8.7
9/24/2018	1.770	2.25	20.3	5.36	7.77	49.0	33.5	15.0	6.9	<1.0	<1.0	2.2
11/30/2018	1.165	0.13	3.1	5.27	7.34	-	5.1	-	-	-	-	-
2/14/2019	1.030	0.15	2.3	6.51	7.30	-	9.4	-	-	-	-	-
3/11/2019	1.115	0.51	0.4	22.81	8.32	-	15.7	-	-	-	-	-
MIN.	**0.960**	**0.02**	**0.4**	**0.82**	**7.24**	**19.0**	**2.40**	**2.6**	**4.9**	**<1**	**<1.0**	**<1.0**
MAX.	**2.325**	**4.80**	**28.1**	**23.22**	**8.58**	**>145.0**	**79.9**	**65.6**	**148.0**	**19.5**	**7.2**	**27.9**
AVG.	**1.333**	**0.85**	**18.0**	**7.28**	**-**	**70.3**	**14.70**	**13.2**	**33.9**	**3.0**	**1.2**	**6.8**
MEDIAN	**1.213**	**0.54**	**22.5**	**5.97**	**7.90**	**65.0**	**12.55**	**10.0**	**26.0**	**<1.0**	**<1.0**	**4.4**

Table F-4: Water Quality Monitoring Results from Samples Collected at Site W-M504.1E

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
12/8/2017	0.520	0.57	3.1	11.40	7.98	-	9.46	-	-	-	-	-
1/31/2018	0.540	0.71	3.7	20.46	8.12	-	29.7	-	-	-	-	-
3/8/2018	0.575	0.64	1.9	11.81	7.89	>57.5	16.8	-	-	-	-	-
6/5/2018	0.770	1.51	22.6	9.44	8.37	52.5	15.0	13.0	49.3	5.3	1.6	9.8
6/19/2018	0.980	1.36	27.9	11.64	8.44	44.5	16.6	19.0	80.5	6.9	4.1	18
7/5/2018	1.810	18.21	28.0	5.41	-	49.0	19.6	32.0	16.4	<1.00	<1.00	5.1
7/17/2018	1.060	1.79	26.7	6.31	8.56	45.0	27.8	24.0	20.2	1.3	<1.00	5.1
7/31/2018	0.915	1.43	23.5	7.51	8.09	55.0	9.76	9.75	14.4	<1.00	<1.00	4.5
8/14/2018	0.560	1.77	26.1	4.58	7.85	29.0	13.4	11.0	12.4	<1.00	<1.00	2.9
8/28/2018	0.590	0.49	25.8	6.12	8.12	34.0	23.5	23.6	40.2	5.1	<1.00	7.1
9/24/2018	1.260	0.98	19.3	6.14	7.79	25.0	33.1	17.8	13.0	<1.0	<1.0	2.0
11/30/2018	0.785	0.45	4.7	4.98	7.37	-	7.6	-	-	-	-	-
2/14/2019	0.645	0.22	2.6	11.68	7.41	-	9.85	-	-	-	-	-
3/11/20119	0.730	0.32	1.9	17.44	7.82	-	195.0	-	-	-	-	-
MIN.	**0.520**	**0.22**	**1.9**	**4.58**	**7.37**	**25.0**	**7.60**	**9.8**	**12.4**	**<1.0**	**<1.0**	**2.0**
MAX.	**1.810**	**18.21**	**28.0**	**20.46**	**8.56**	**>57.5**	**195.0**	**32.0**	**80.5**	**6.9**	**4.1**	**18.0**
AVG.	**0.839**	**2.18**	**15.6**	**9.64**	**-**	**43.5**	**30.51**	**18.8**	**30.8**	**2.6**	**1.1**	**6.8**
MEDIAN	**0.750**	**0.85**	**21.0**	**8.48**	**7.98**	**45.0**	**16.70**	**18.4**	**18.3**	**0.9**	**<1.0**	**5.1**

Table F-5: Water Quality Monitoring Results from Samples Collected at Site W-M505.7C

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
6/6/2017	3.230	85.20	22.5	9.23	8.09	28.0	41.7	54	215	<1	21.9	44.2
6/20/2017	1.645	33.64	23.8	6.55	7.87	16.5	104	126	30.1	<1.0	1.9	13
7/5/2017	1.270	35.15	24.4	6.96	7.84	20.0	78.2	108	12.9	<1	<1	1.6
7/18/2017	1.100	2.56	25.4	7.34	8.15	21.0	66.8	96.5	93.6	3.6	5.4	23.6
8/1/2017	1.390	53.05	22.8	6.41	7.54	28.0	4.77	125	16.4	<1.0	<1.0	5.1
8/15/2017	1.010	12.81	23.4	8.41	8.52	39.0	31.8	50	124	5.9	10.9	17.2
8/29/2017	0.980	18.95	21.6	6.91	8.06	28.0	45.8	66	84.7	2	6.2	10.1
9/12/2017	0.820	4.85	20.3	7.56	8.17	28.0	34.9	68.4	98	2.3	8.2	13.9
12/8/2017	0.780	13.65	2.1	14.09	8.34	64.0	14.2	-	-	-	-	-
1/31/2018	0.840	18.26	0.8	12.89	7.86	50.0	23.2	-	-	-	-	-
3/8/2018	0.950	15.14	1.6	12.48	7.84	30.0	37.3	-	-	-	-	-
6/5/2018	1.190	26.06	23.9	7.69	8.34	25.5	56.8	105	56.8	2.1	2.2	12
6/19/2018	1.420	37.75	26.2	4.95	7.64	25.0	44	57.2	8.4	<1.0	<1.0	3.6
7/5/2018	2.240	68.06	27.7	5.93	-	36.0	30.1	41.1	20.8	<1.00	<1.00	2.1
7/17/2018	1.800	49.38	26.8	6.18	8.47	19.0	82.4	89.6	31.2	<1.00	<1.00	10.3
7/31/2018	1.390	27.68	25.1	7.95	8.4	32.0	34.3	60.4	133	8	7.5	23.7
8/14/2018	0.920	14.76	25.8	6.98	8.07	27.0	58.7	71.3	57.7	1.3	3.7	7.5
8/28/2018	0.880	17.66	25.8	7.01	8.36	27.0	60.5	71.2	111	2.1	9.4	15.4
9/24/2018	1.840	53.75	19.0	7.02	7.82	28.0	32.9	39.0	4.8	<1.0	<1.0	1.0
11/30/2018	1.215	19.00	1.9	13.43	8.03	95.0	8.89	-	-	-	-	-
2/14/2019	1.000	19.72	0.3	12.35	7.56	-	14.9	-	-	-	-	-
3/11/2019	1.090	17.03	0.5	11.8	7.55	12.0	174	-	-	-	-	-
MIN.	**0.780**	**2.56**	**0.3**	**4.95**	**7.54**	**12.0**	**4.77**	**39.0**	**4.8**	**<1.0**	**<1.0**	**1.0**
MAX.	**3.230**	**85.20**	**27.7**	**14.09**	**8.52**	**95.0**	**174.0**	**126.0**	**215.0**	**8.0**	**21.9**	**44.2**
AVG.	**1.318**	**29.28**	**17.8**	**8.64**	**-**	**32.3**	**49.1**	**76.8**	**68.7**	**2.0**	**5.0**	**12.8**
MEDIAN	**1.145**	**19.36**	**23.1**	**7.45**	**8.06**	**28.0**	**39.5**	**69.8**	**57.3**	**0.9**	**3.0**	**11.2**

Table F-6: Water Quality Monitoring Results from Samples Collected at Site W-M505.0B

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
6/6/2017	3.830	68.71	22.3	9.3	8.11	28.0	40.1	61.6	210	<1	20.8	68.5
6/20/2017	3.310	38.30	24.4	6.7	7.98	20.0	69.7	79.6	30.1	<1	1.9	13
7/5/2017	2.990	44.53	24.8	7.24	7.94	21.0	52.4	64.0	14.3	<1	<1	4.4
7/18/2017	2.860	2.57	25.9	7.49	8.13	28.0	59.2	81.0	108	1.6	8.7	26.8
8/1/2017	3.120	36.02	23.4	6.7	7.62	39.5	32.7	52.4	16.9	<1.0	<1.0	3.2
8/15/2017	2.770	14.65	23.8	8.94	8.63	44.5	25.8	36.0	132	5.9	12.2	15.2
8/29/2017	2.780	25.38	21.9	7.15	8	38.0	34.3	47.7	84	2.5	7.5	11
9/12/2017	2.700	19.66	20.6	8.07	8.3	35.0	41.8	44.8	83	1.4	6.9	8.3
12/8/2017	2.740	16.74	2.3	14.12	8.32	61.0	12.5	-	-	-	-	-
1/31/2018	2.650	14.44	1.0	12.88	7.82	50.0	25.3	-	-	-	-	-
3/8/2018	2.755	16.64	1.8	12.56	7.77	37.0	33.6	-	-	-	-	-
6/5/2018	2.870	32.67	24.3	7.8	8.38	33.0	45.1	70.5	52.8	1.5	2.2	11.2
6/19/2018	3.060	41.57	26.7	5.3	7.67	29.0	29.8	40.9	10	<1.0	<1.0	3.1
7/5/2018	4.090	77.00	27.7	5.83	-	34.0	26.7	48.3	21.6	<1.00	<1.00	1.9
7/17/2018	3.305	54.44	27.1	6.29	8.52	23.0	57.3	66.8	22.9	1.1	<1.00	7.2
7/31/2018	2.960	26.90	25.5	8.27	8.44	37.0	25.8	44.8	106	6.7	5.2	18.6
8/14/2018	2.570	21.40	27.1	8.29	8.33	33.0	34.4	41.2	58.3	1	3.6	<1.00
8/28/2018	2.480	14.34	26.1	7.72	8.46	27.0	43.4	50.4	90.7	<1.00	6.4	7.8
9/24/2018	3.230	48.31	19.1	6.14	7.83	19.1	43.7	50.0	4.7	<1.0	<1.0	<1.0
11/30/2018	2.810	20.99	2.0	13.35	7.97	81.0	9.27	-	-	-	-	-
2/14/2019	2.630	16.32	0.6	12.48	7.58	-	15.3	-	-	-	-	-
3/11/2019	2.735	16.65	0.9	12	7.57	12.0	159	-	-	-	-	-
MIN.	**2.480**	**2.57**	**0.6**	**5.30**	**7.57**	**12.0**	**9.27**	**36.0**	**4.7**	**<1.0**	**<1.0**	**<1.0**
MAX.	**4.090**	**77.00**	**27.7**	**14.12**	**8.63**	**81.0**	**159.0**	**81.0**	**210.0**	**6.7**	**20.8**	**68.5**
AVG.	**2.966**	**30.37**	**18.2**	**8.85**	**-**	**34.8**	**41.7**	**55.0**	**65.3**	**1.6**	**4.9**	**12.6**
MEDIAN	**2.835**	**23.39**	**23.6**	**7.94**	**8.00**	**33.0**	**34.4**	**50.2**	**55.6**	**0.8**	**2.9**	**8.1**

FIGURE F-2. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.7S DURING SUMMER 2015

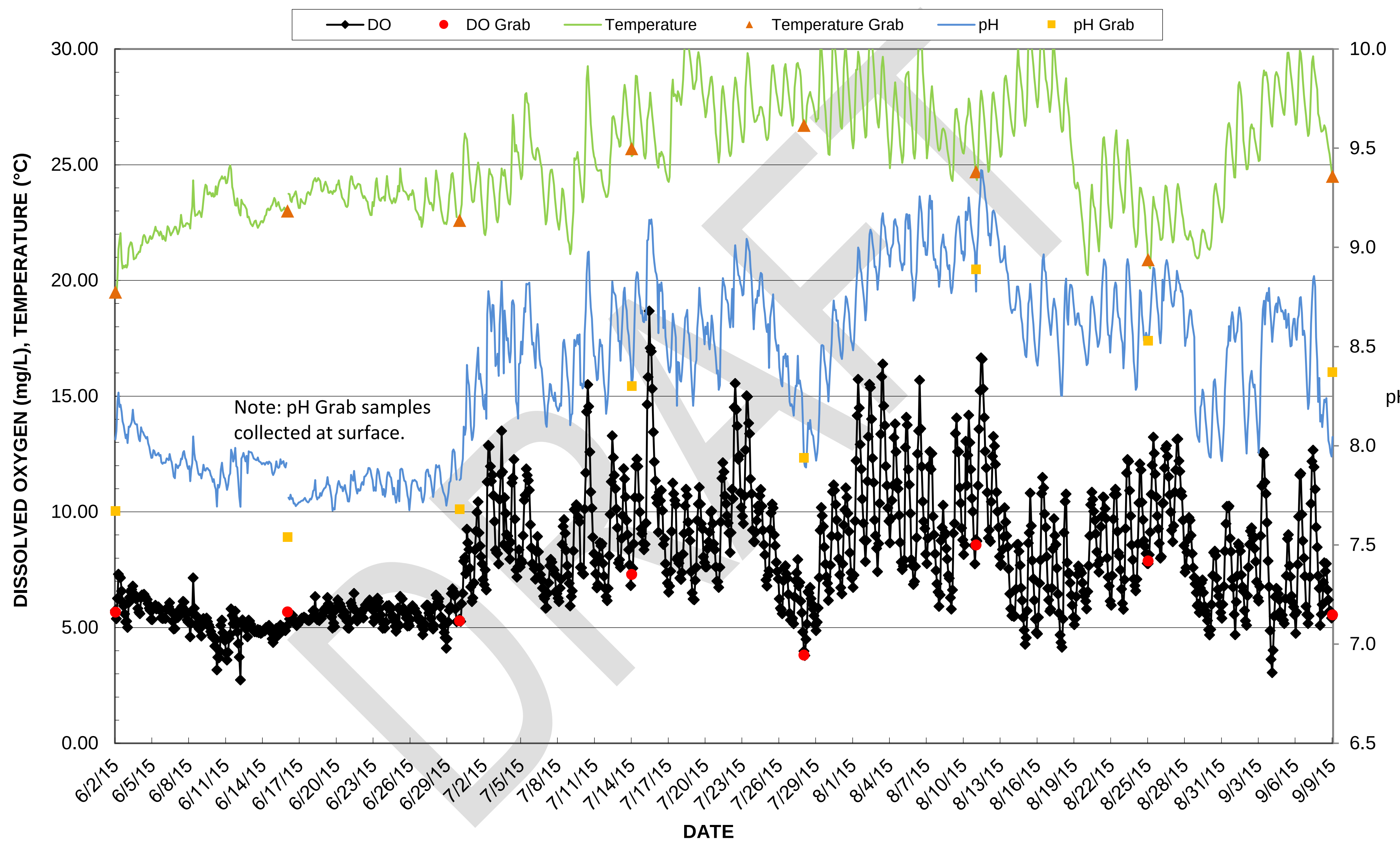


FIGURE F-3. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.7S DURING SUMMER 2016

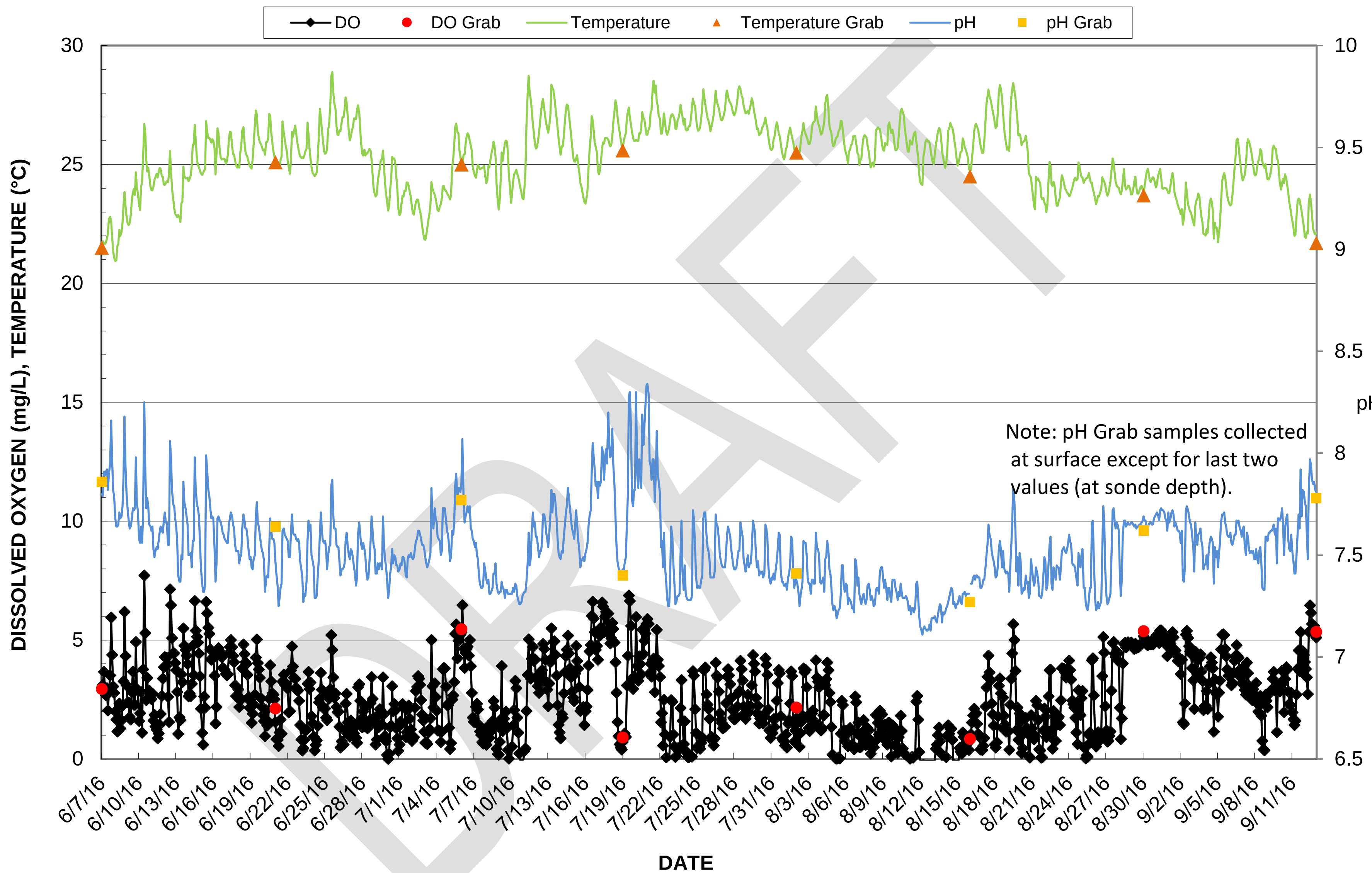


FIGURE F-4. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.7S DURING WINTER 2018-2019

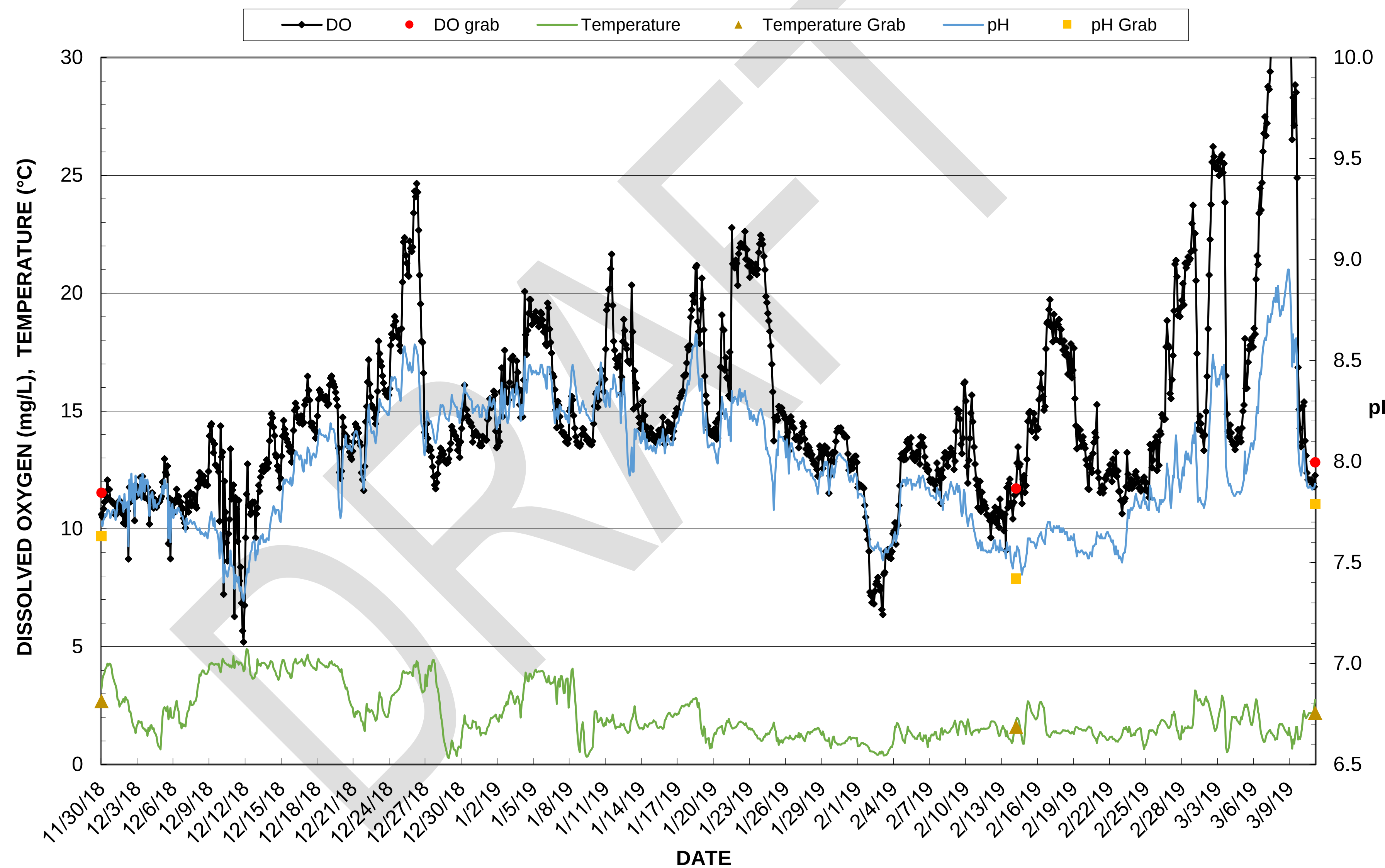


FIGURE F-5. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.9P DURING SUMMER 2017

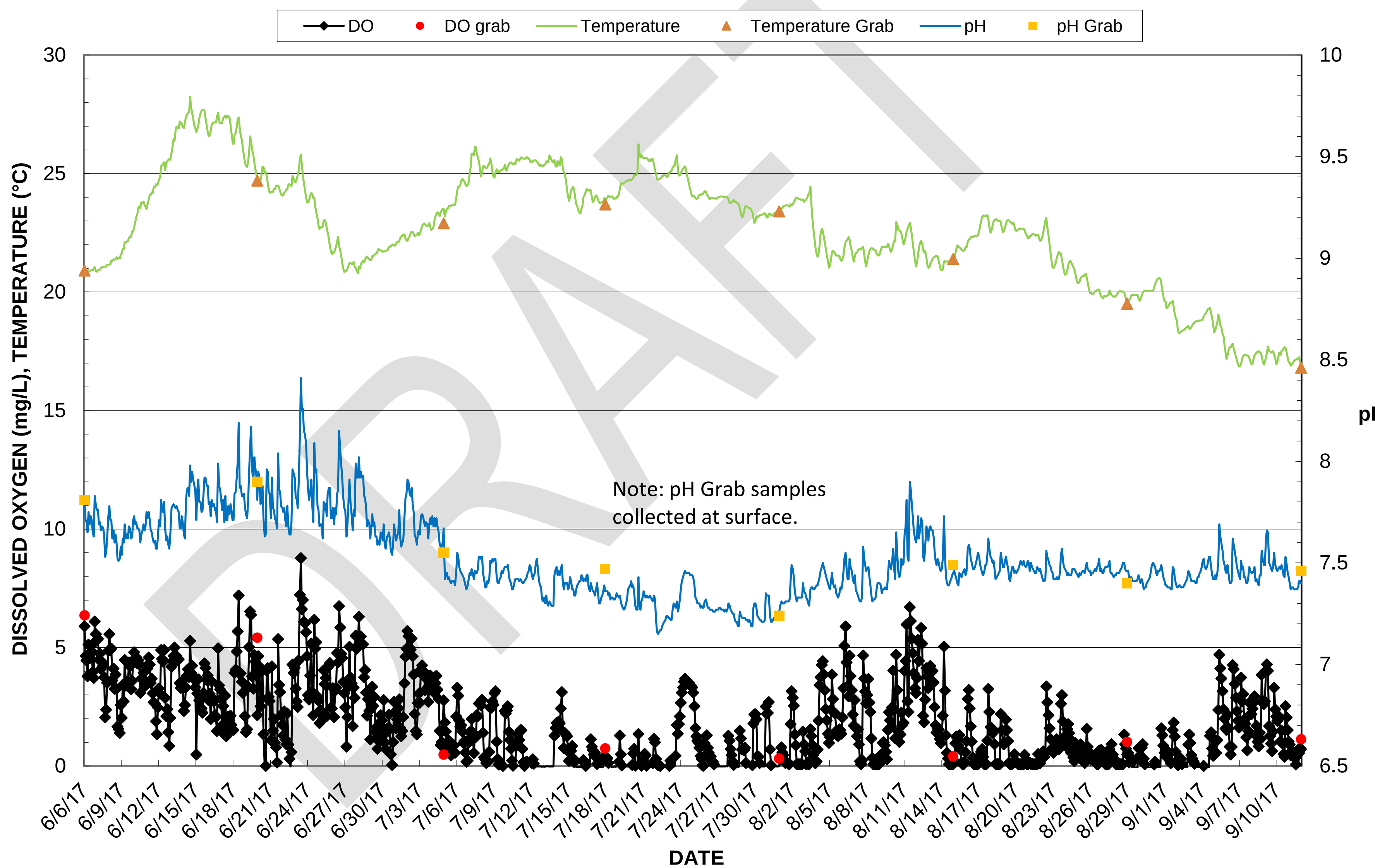


FIGURE F-6. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.9P DURING SUMMER 2018

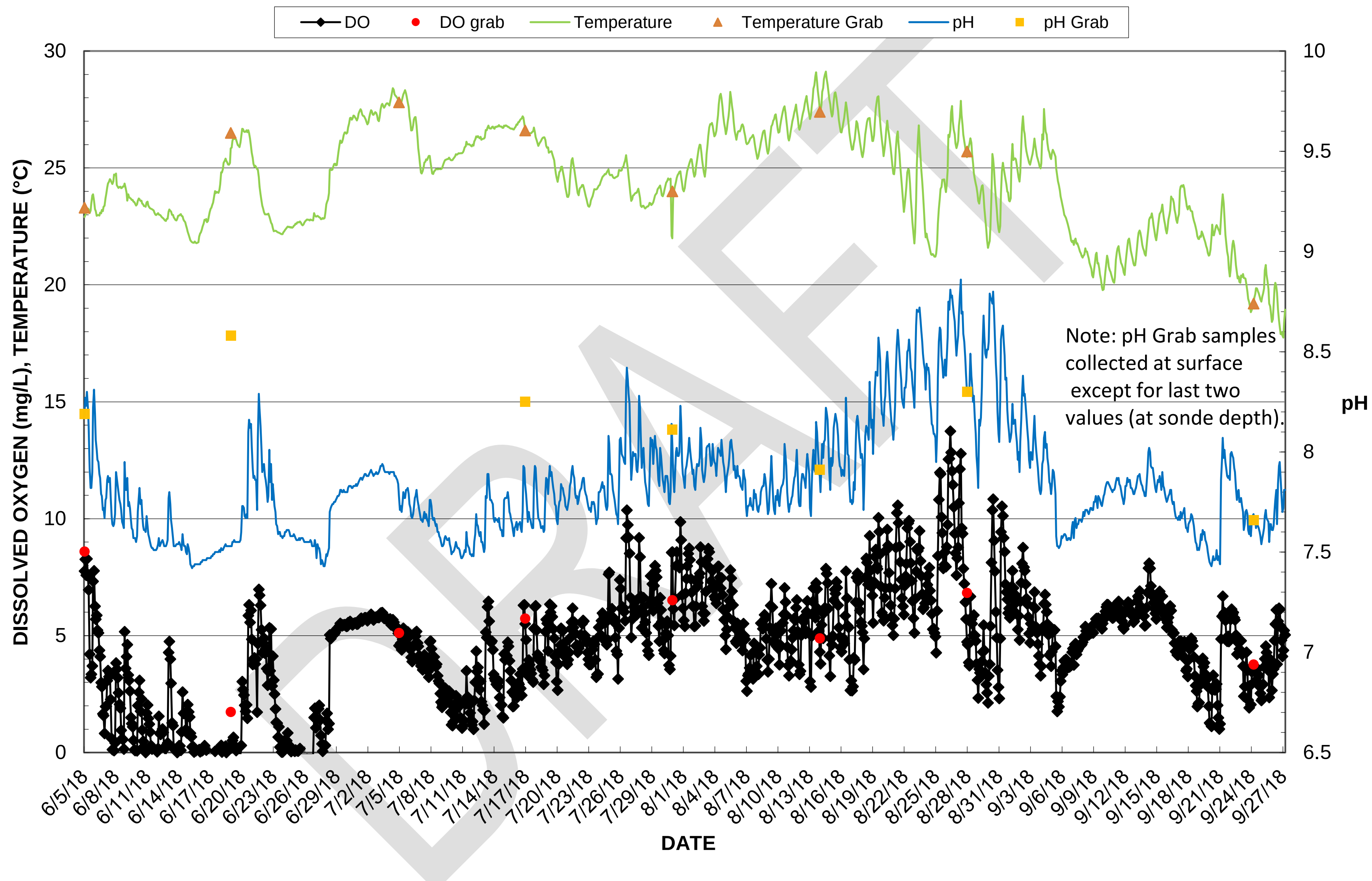


FIGURE F-7. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.9P DURING WINTER 2017-2018

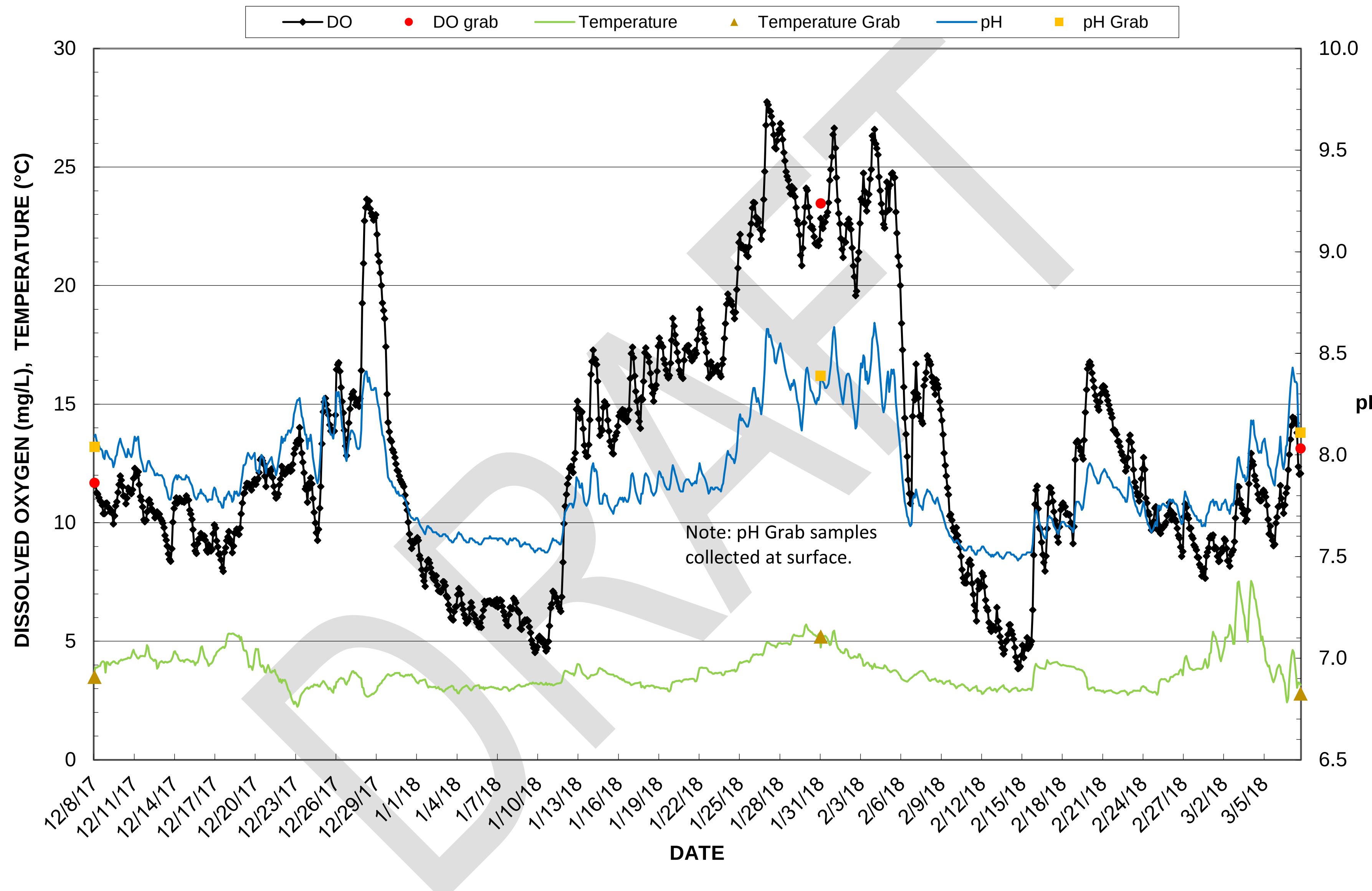


FIGURE F-8. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.9P DURING WINTER 2018-2019

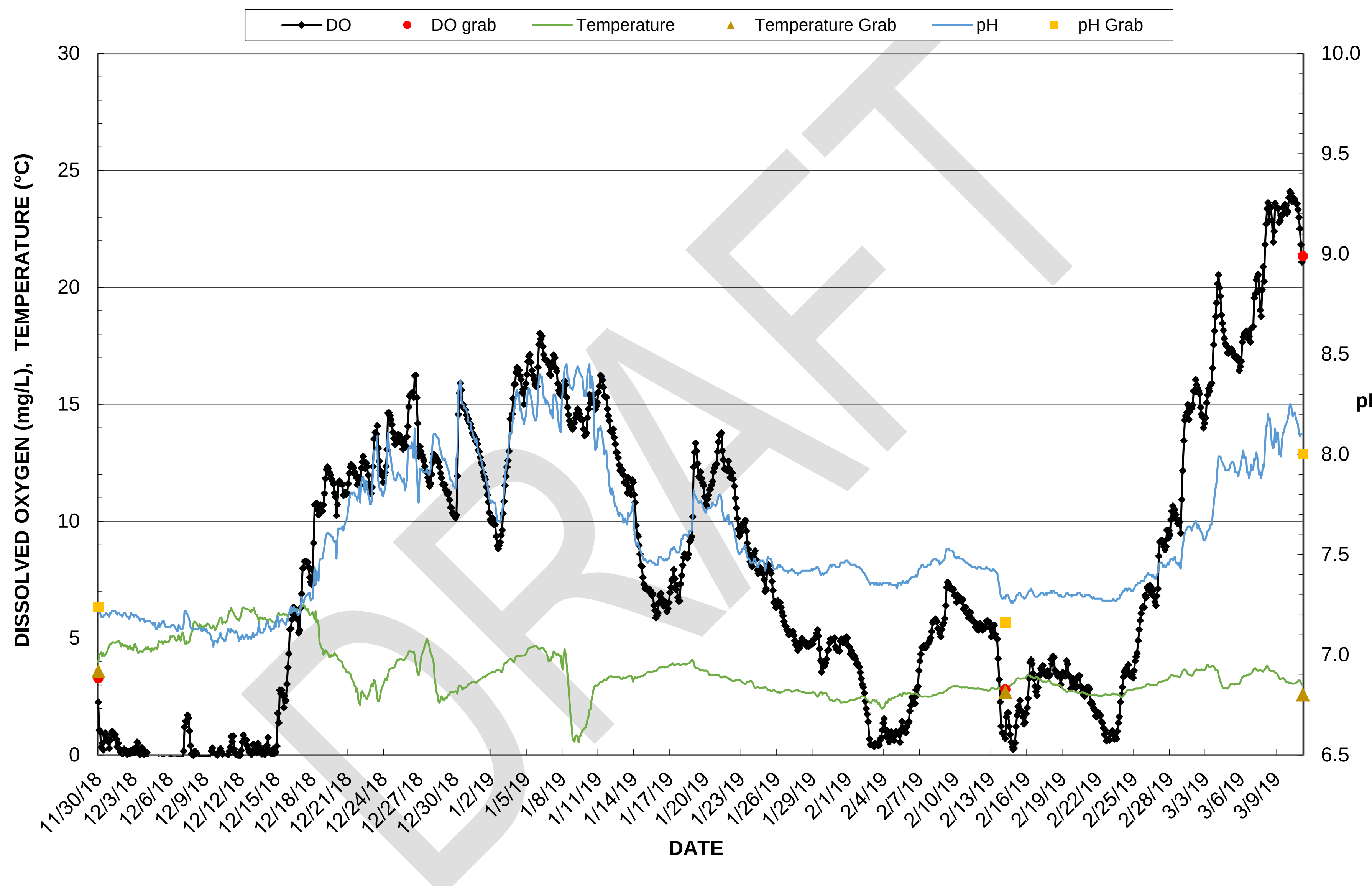


FIGURE F-9. BOXPLOT OF SECCHI DISK DEPTH MEASUREMENTS COLLECTED DURING THE SUMMER MONTHS

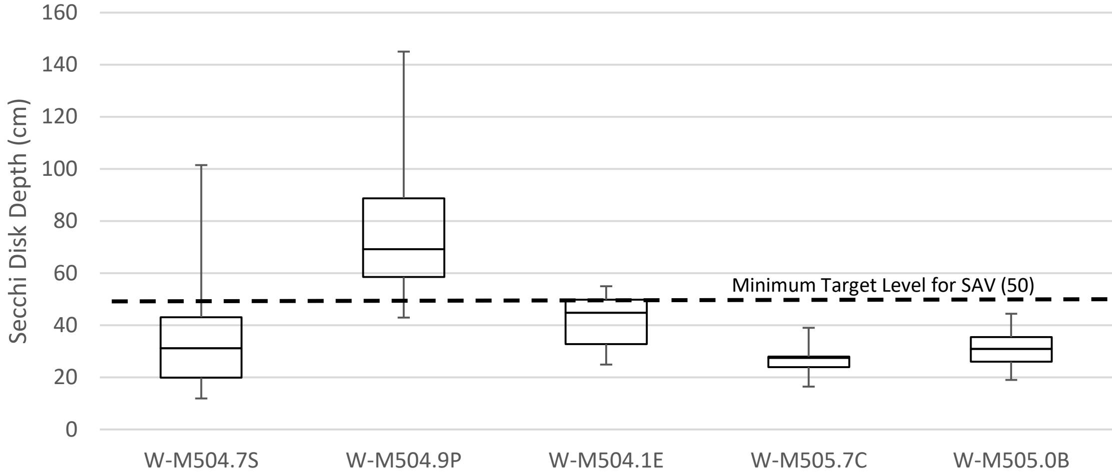


FIGURE F-10. BOXPLOT OF TOTAL SUSPENDED SOLIDS CONCENTRATIONS COLLECTED DURING THE SUMMER MONTHS

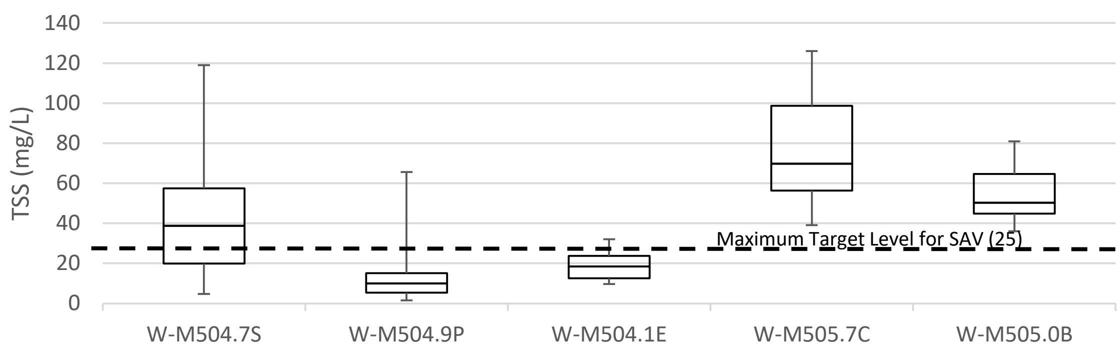
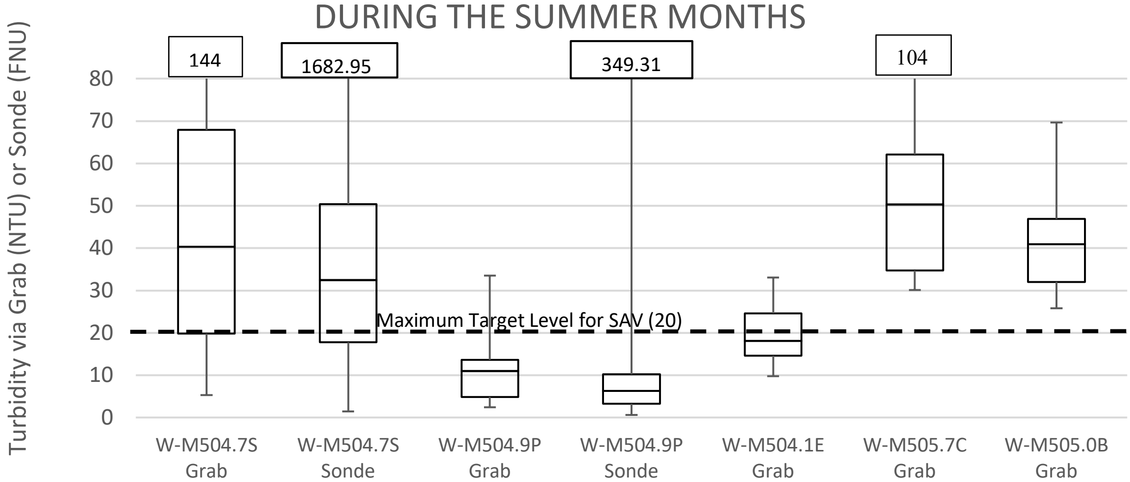


FIGURE F-11. BOXPLOT OF TURBIDITY VALUES COLLECTED DURING THE SUMMER MONTHS



UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX G

GEOTECHNICAL CONSIDERATIONS

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX G

GEOTECHNICAL CONSIDERATIONS

FIGURES

APPENDICES

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
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STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX G

GEOTECHNICAL CONSIDERATIONS

I. PURPOSE AND SCOPE

This appendix presents the general geology and specific geotechnical analyses relevant to the Steamboat Island HREP (Project) (Anderson, 1983; Prior, 1976). The Rock Island District (District) Engineering and Construction Division's Geotechnical Branch obtained representative soil borings, performed laboratory analysis and interpretation, and provided sufficient geotechnical analyses and recommendations to support the recommended plan alternatives. Final exploration, subsurface characterization, and geotechnical design will be performed during the engineering and design phase. Figure G-1 shows the TSP, as described in Section VI of the Main Report.

II. PHYSIOGRAPHY

The Project area is situated within the Dissected Till Plains Section of the Central Lowlands Province of the Interior Plains. The Project area has little topographic relief and consists of shallow backwaters, bottomland, and islands that are subject to permanent high water tables and annual flooding.

III. GEOLOGY

The Project lies entirely within the Mississippi River floodplain, which consists of alluvial soils at and near the surface and glacial deposits at depths. The surface stratum is usually clay, varying in thickness from about 3 to 20 feet. This is underlain by a sand and gravel stratum, which extends to an intermittent glacial till clay at a depth of 40 to 80 feet or to bedrock at a depth of 120 to 160 feet.

IV. SURFICIAL SOILS

The USDA NRCS publishes soil surveys for most counties in the United States (NRCS, Web Soil Survey). Information contained in these reports pertains to soil within 5 feet of the surface. These soils are mapped by soil series. A soil series is a group of soils having almost identical profiles. All soils of a particular series have horizons that are similar in compositions, thickness, and arrangement.

Information contained in the NRCS Web Soil Survey indicated that the dominant soil type present in and around the Project area is generally classify as Ambraw-Perks-Lawson complex, which is described as an alluvium product in the NRCS classification system. This series is described as frequently flooded, poorly drained soil with a water table that varies between ground surface and 1 foot deep. See Figure G-2 for the results of the Project area NRCS Web Soil Survey.

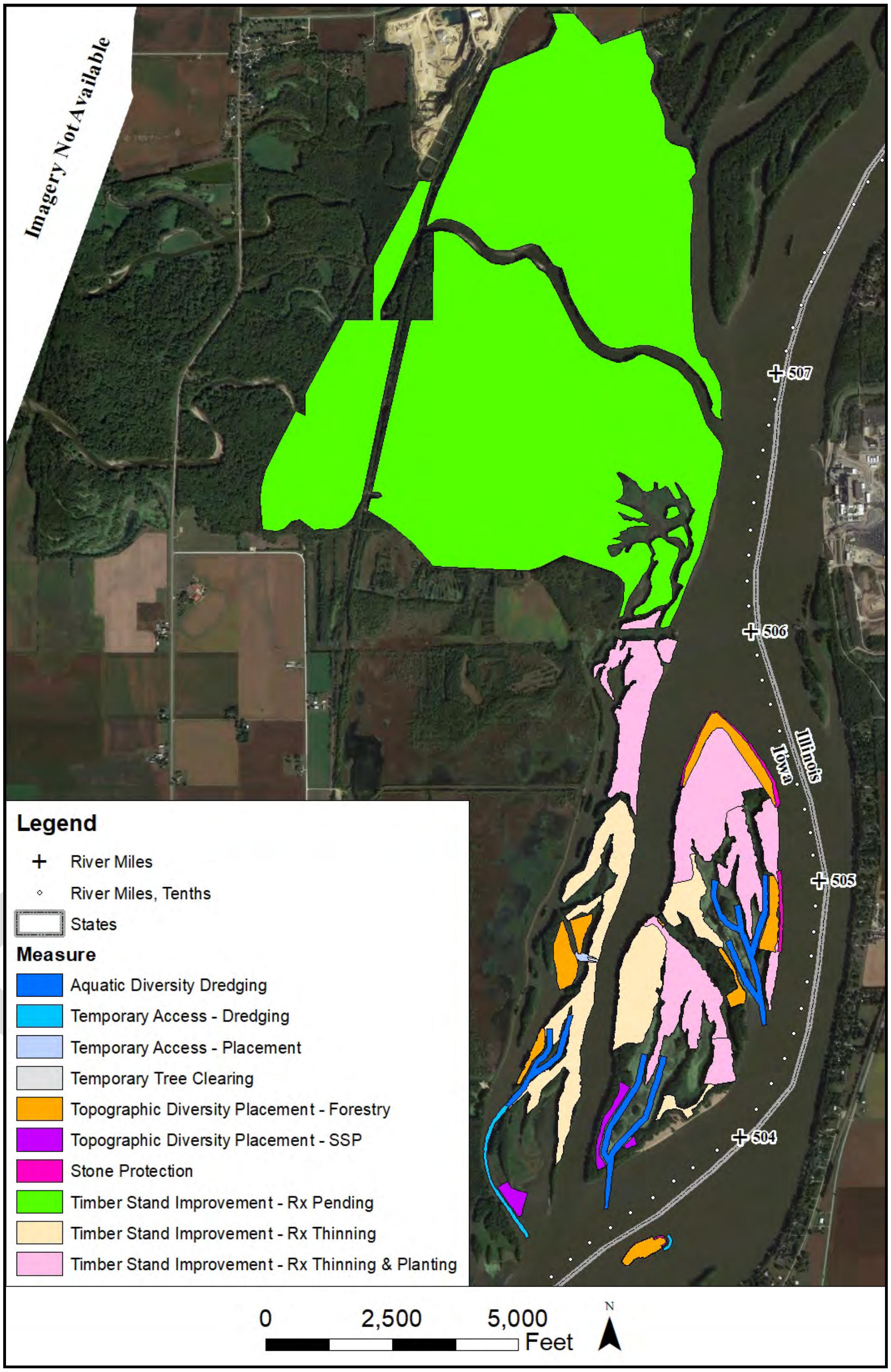

Figure G-1: Tentatively Selected Plan

Scott County, Iowa (IA163)
Rock Island County, Illinois (IL161)

Rock Island County, Illinois (IL161)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
W	Water	0.7	0.1%
Subtotals for Soil Survey Area		**0.7**	**0.1%**

Scott County, Iowa (IA163)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1539	Ambraw-Perks-Lawson complex, frequently flooded, 0 to 2 percent slopes	343.4	45.5%
W	Water	410.0	54.4%
Subtotals for Soil Survey Area		**753.4**	**99.9%**
Totals for Area of Interest		**754.0**	**100.0%**

Figure G-2: Results of Project Area NRCS Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

V. SUBSURFACE EXPLORATION

District Geotechnical Branch personnel conducted subsurface exploration using a 4-inch diameter Iwan-style hand-auger on October 3, 2018, and a 2 ¾ -inch OD vibrocore sampler on October 4, 2018, in order to characterize the composition and engineering properties of the soils present at the Project site. Borings were taken at the locations shown on Sheet B-101 (Appendix G-A).

Borings SB-18-06, 07, 08, and 09 were taken within the Grant Slough Complex. Borings SB-18-01, 02, 03, 04, and 05 were taken within the downstream end of Steamboat Island. Borings SB-18-10, 11, 12, 13, 14, and 15 were taken within the upstream end of Steamboat Island. Samples were taken at sufficient intervals to classify all the strata encountered at each boring location. Representative samples were taken for visual soil classification and moisture content from all recovered soils. Atterberg limit tests were performed on several of the clay samples gathered throughout the site to verify soil classifications and to characterize stratigraphy. Boring logs can be found on Sheets B-601 and B-602 (Appendix G-A).

VI. LABORATORY TESTING

All fine-grained samples were analyzed for water content. The average water content of the fine-grained samples was 62.0 expressed as percentage of total sample weight.

Atterberg limit tests were performed on several of the clay samples gathered throughout the site in order to confirm visual classifications. Results for liquid limits ranged between 45 and 83, and plastic limits between 20 and 32.

VII. STRATIGRAPHY

The borings ranged up to approximately 12 feet below average water surface elevation during the 2-day period that the borings were completed (575.35 NAVD88). Below ground surface materials depths ranged between 4.5 and 7.0 feet and are composed of lean, medium, and fat clays. Various types of granular materials were encountered beneath the clays in most borings. Medium to fine sand lenses were found sporadically in most borings.

VIII. SITE CHARACTERIZATION

In order to prepare the appropriate geotechnical analyses for design of the selected Project measures, it was necessary to characterize the Project according to typical clay and sand foundation depths and strengths, typical embankment heights and strengths, and water depths. All boring logs and river bottom transects were analyzed in detail.

The top of sand foundation will be taken as elevation 565.0. Sand foundation strength will be taken as 28 degrees angle of internal friction. The top of clay foundation at dredged material placement sites will be taken as elevation 573.0. Foundation clay unconsolidated-undrained (end-of-construction) shear strengths were obtained by the District's moisture content correlation (Figure G-3). Clay foundation strength will be taken as either 300 psf cohesion unconsolidated-undrained strength or an assumed drained strength of ϕ = 19 degrees angle of internal friction in accordance with the plasticity correlations contained in Duncan et. al, 1989.

Although the TSP design includes placement of dredged material to create topographic diversity up to elevation 576.2, the top of topographic diversity (embankment) is assumed to be elevation 580.0 here to account for future design variation.

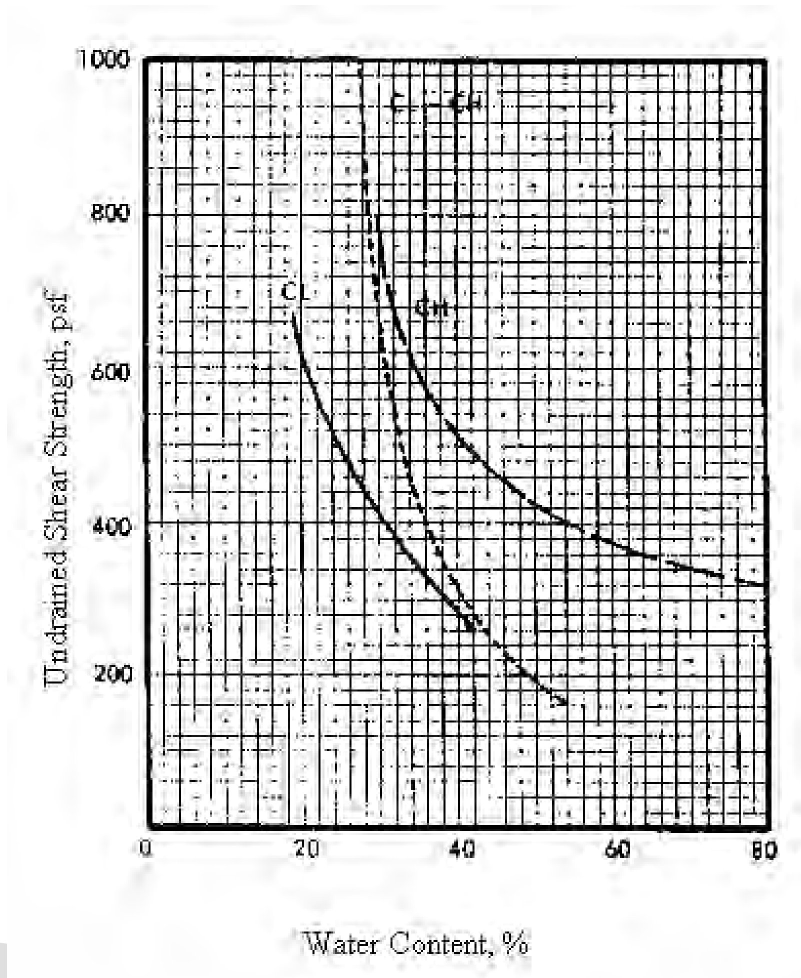

Figure G-3: MVR Unconsolidated-Undrained Shear Strengths

Uncompacted earth embankment strengths were difficult to estimate due to the nature of the proposed placement method. As described below, the embankments will most likely be placed by the clamshell dredging method, with part occurring under water. Double-handling of material may also be required. Critical shear strengths could vary between remolded and unconsolidated-undrained. The unconsolidated-undrained foundation shear strengths described above are considered pertinent to the uncompacted earth embankment strengths since the foundation soils would be used in the embankment construction. Remolded shear strengths for uncompacted earth embankment design were also considered, since the soil would be at least partially disturbed and remolded by the mechanical dredging operations. The uncompacted earth embankment strength will be taken as 200 psf cohesion due to the remolded strength reduction. Rock (riprap for grade control structure and bank protection) shear strength parameters will be taken as c=0 and ϕ=45 degrees.

IX. DREDGING DESIGN

Project measures include mechanical dredge cuts in order to provide both excavation for aquatic diversity and borrow material for uncompacted earth embankment construction.

The preferred dredging technique for clay is mechanical. Review of the boring logs indicates that the in-place uncompacted embankment borrow material is soft to firm clay. A mechanical dredging method is required to minimize disturbance of the borrow soils so that maximum possible soil strength is realized during and after uncompacted embankment construction. Three-cubic-yard minimum-capacity clamshell bucket and excavators have been successfully utilized at similar projects. A large-capacity clamshell bucket that is specifically designed for removal of any firmer in situ clays may be necessary. The bottom 15% (approximate) of the total depth of dredge cut will occur in the underlying sand foundation.

Uncompacted earth embankments will be constructed using mostly (approximately 85%) mechanically-dredged fine sediments. It must be stressed that embankment construction by clamshell dredging of fine sediments is not ideal. Soil strength estimation is difficult, especially when placement is made under water, because compaction of cohesive soils cannot occur. The contractor will not be allowed to 'throw' the material from the clamshell, but must 'place' the clamshell on the placement area ground surface and then release the material in order to obtain maximum strength from the in situ borrow material.

X. STABILITY

The foundation and embankment engineering properties were characterized previously in this appendix. The bottom of the dredge cut was taken as elevation 563.0. An idealized dredge cut section was developed to determine stability as shown in Figure G-4.

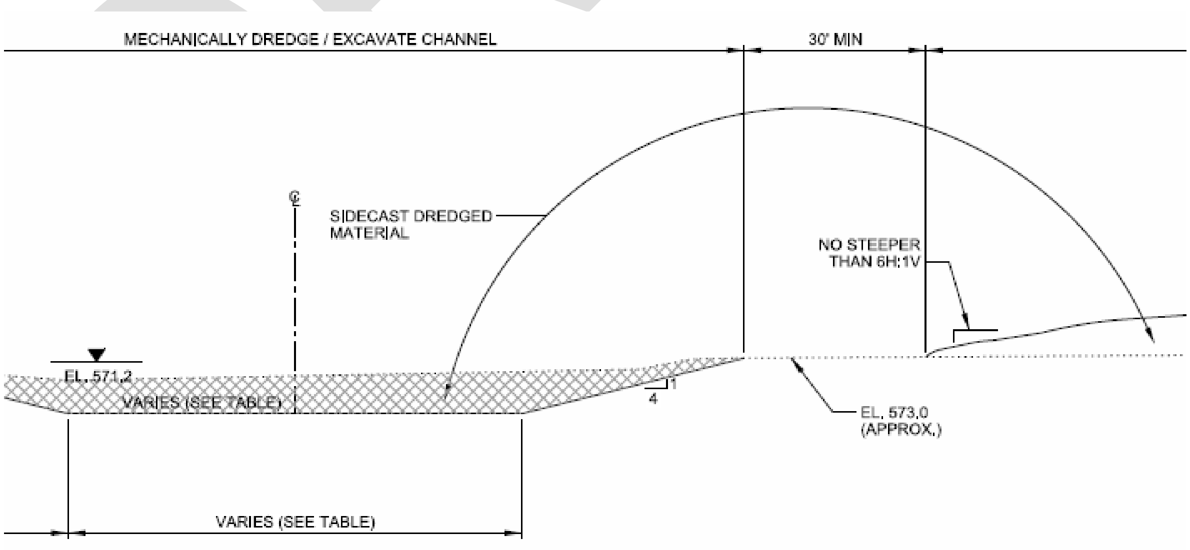

Figure G-4: Typical Section, Dredge Cut and Placement Area

The foundation and embankment engineering properties were characterized previously in this appendix. The bottom of the dredge cut was taken as elevation 563.0. An idealized dredge cut section was developed to determine stability as shown in Figure G-4.

Both drained and undrained clay foundation strength parameters were modeled with GeoStudio slope stability package (GeoStudio 2016). As described in EM 1110-2-1902 (USACE, 1970), the dredge cut will not be subjected to pool fluctuation, seepage, or earthquake forces. The in situ strength of dredge cut area soil prior to unloading was considered most critical due to the apparent strength gain from negative soil pore water pressures upon unloading. The program was run in the search mode, and numerous other surfaces were modeled, as shown in Appendix G-B. The stability analyses of the dredge cut slope revealed that the drained condition was found to be the most critical and resulted in a factor of safety against sliding for the 4H:1V cut slopes of 1.28, as shown in Figure G-5.

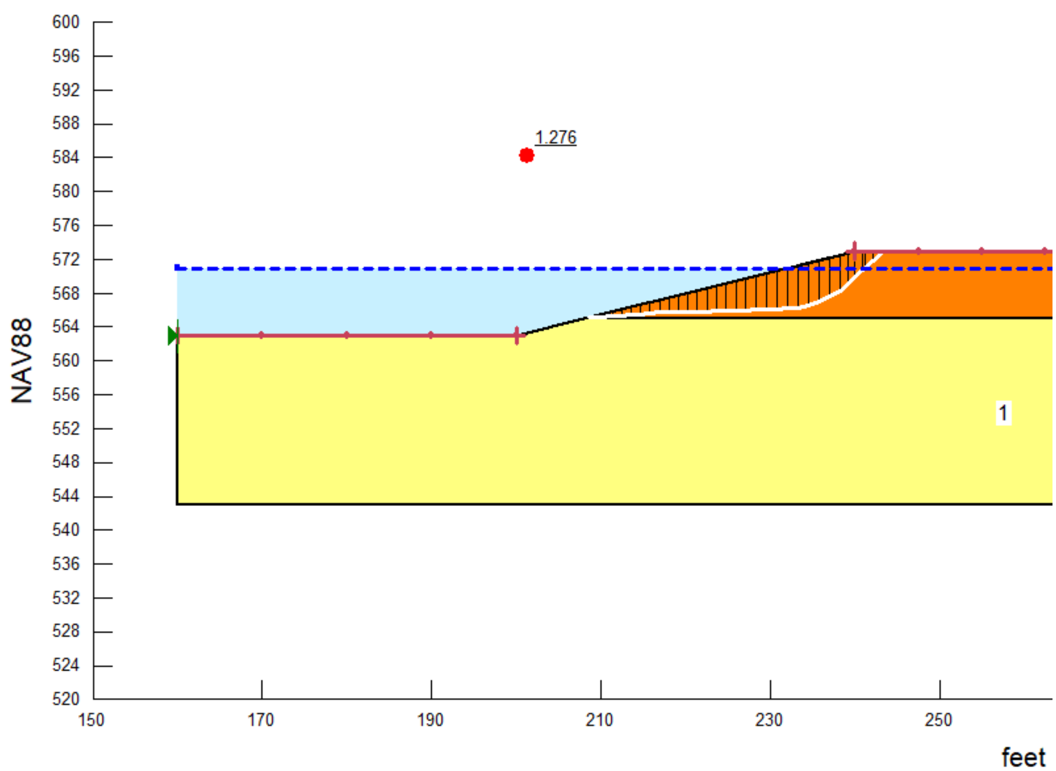

Figure G-5: Critical Slip Surface

It is recommended that the cut slopes be placed no closer than 30 feet from the toe of the uncompacted embankment and other dredged material placement areas in order to avoid influence on both the uncompacted earth embankment and the dredge cut stabilities. Contracting a mechanical dredge large enough to reach the entire placement area from the excavated channels may prove problematic. In this case, a minimum clearance distance of 20 feet can be allowed, as long as localized embankment and dredge cut slope failures are acceptable. Instantaneous isolated embankment and shallow foundation failures can be expected due to the unpredictable nature of the borrow material and placement method. Fine embankment and foundation soils will gain strength and greater stability with time as the cohesive soils are allowed to consolidate and drain. Double handling of dredged material or two or more dredge cuts may also be necessary. In any case, construction contract duration will be structured to account for irregularities in both uncompacted earth embankment and cut slope strengths. The contract duration is expected to be two to three years in order to account for these, as well as unpredictable flooding and time for embankment material drying, consolidation, and strength gain issues which will dictate when all excavation can be completed. Similar projects have been completed with a three-year contract duration and/or separate stages for channel excavation and final shaping and been successful. This Project may include a second stage for both 'final embankment shaping' and all of the related habitat plantings that are planned.

XI. SETTLEMENT AND SHRINKAGE

Settlement calculations are not considered relevant to this Project due to the following: 1) relatively thin top clay layer with minimal settlement, 2) unpredictable desiccation, drying, and consolidation shrinkage of the uncompacted embankment, and 3) significant time lapse (at least two years) for the majority of the foundation settlement and uncompacted embankment desiccation and drying to occur prior to 'final shaping' of the embankment. Based upon similar projects, the shrinkage of the uncompacted embankment due to drying, desiccation, and consolidation is estimated at 15%. Additional surveys will be completed following the majority of settlement and shrinkage and shortly before commencement of any final shaping and planting work.

XII. EROSION PROTECTION

Erosion protection stone is proposed for the bank protection for the Upper Steamboat Island (USI) Head restoration and protection, the West SE Island restoration and protection, the NE Bank restoration and protection, and the Grade Control Structure (GCS). Hydraulic analysis and design (Appendix H, *Hydrology and Hydraulics*) was done to select a minimum rock gradation/thickness and slope that will resist both river current and wave attack for these features. The following selected rock protection exceeded the minimum recommendation based upon ice flow durability considerations.

USI Head - Iowa Class B Revetment, or equivalent
- Nominal top size of 650 pounds
- At least 20% of the stones are to weigh more than 500 pounds
- At least 50% of the stones are to weigh more than 275 pounds
- At least 90% of the stones are to weigh more than 25 pounds

West SE Island - Iowa Class B Revetment, or equivalent
- Nominal top size of 650 pounds
- At least 20% of the stones are to weigh more than 500 pounds
- At least 50% of the stones are to weigh more than 275 pounds
- At least 90% of the stones are to weigh more than 25 pounds

NE Bank - Iowa Class C Revetment, or equivalent
Nominal top size of 450 pounds
At least 50% of the stones weighing more than 275 pounds
At least 90% of the stones weighing more than 75 pounds

GCS - Iowa Class E Revetment, or equivalent
Nominal top size of 250 pounds
At least 50% of the stones are to weigh more than 90 pounds
At least 90% of the stones are to weigh more than 5 pounds

The recommended minimum thickness of the USI Head and West SE Island bank erosion protection is three feet, and placed on a slope no steeper than 1.5H:1V. The recommended minimum thickness of the NE Bank erosion protection is 2 feet. The GCS slopes will be no steeper than 1.5H:1V. Stability and settlement considerations are minimal for these measures, since near-surface sand comprises their foundations.

The recommended rock erosion protection is available locally.

XIII. RECOMMENDATIONS

- **Uncompacted Earth Embankments**
  - Provide slopes no steeper than 6H:1V.
  - Place the embankment material carefully. A minimum mechanical dredge bucket capacity of 3.0 cubic feet is recommended to minimize borrow material disturbance and to maximize uncompacted embankment strength.
  - Place uncompacted earth embankments no closer than 30 feet from dredge cuts.
  - Allow minimum 2-year contract duration to allow for adequate drying, desiccation, and consolidation prior to final shaping and planting stage.

- **Dredge Cuts**
  - Dredge the cut slopes no steeper than 4H:1V.
  - Place the dredge cut slopes no closer than 30 feet from uncompacted embankment toes.

- **Rock**
  - Provide slopes no steeper than 1.5H:1V.
  - Use Iowa Class B Revetment for the USI Head and West SE Island measures, Iowa Class C Revetment for the NE Bank measure, and Iowa Class E Revetment for the GCS.

XIV. REFERENCES

Anderson, Wayne (1983), Geology of Iowa, The Iowa State University Press, Ames, IA.

Duncan, J.M., Horz, R.C., and Yang, T. L. (1989), Shear Strength Correlations for Geotechnical Engineering, Department of Civil Engineering, Virginia Polytechnic University, Blacksburg, VA.

GeoStudio 2016, version 8.16.3.14580 Copyright © 1991-2017 GEO-SLOPE International Ltd, Calgary, Alberta, Canada.

Prior, Jean (1976), A Regional Guide to Iowa Landforms, Iowa Geological Survey, Iowa City, IA.

USACE (1970), Engineer Manual 1110-2-1902: *Stability of Earth and Rockfill Dams*, U.S. Army Corps of Engineers, Washington, DC.

Web Soil Survey, (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) (Last Modified: 04/09/2019) Natural Resources Conservation Service, U.S. Department of Agriculture, Washington, DC.

APPENDIX G-A

BORING LOCATIONS AND LOGS

1 2 3 4 5

A1 BORING LOCATIONS

SCALE : 1"=1000'-0"

0 1000' 2000'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: | DATE:
DWN BY: | CKD BY: | SOLICITATION NO.:
SUBMITTED BY: | CONTRACT NO.:
PLOT SCALE: AS SHOWN | PLOT DATE: | PROJECT CODE: B5MRSI1801
SIZE: ANSI D | FILE NAME: B5MRSI1801_B-101xxx.dgn

MISSISSIPPI RIVER
RIVER MILES 502.5 - 506.5
SCOTT COUNTY, IA
STEAMBOAT ISLAND HREP
FEASIBILITY REPORT

PLAN
BORING LOCATIONS

Sheet ID
B-101

REVIEW

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5/9/2019 11:17:46 AM
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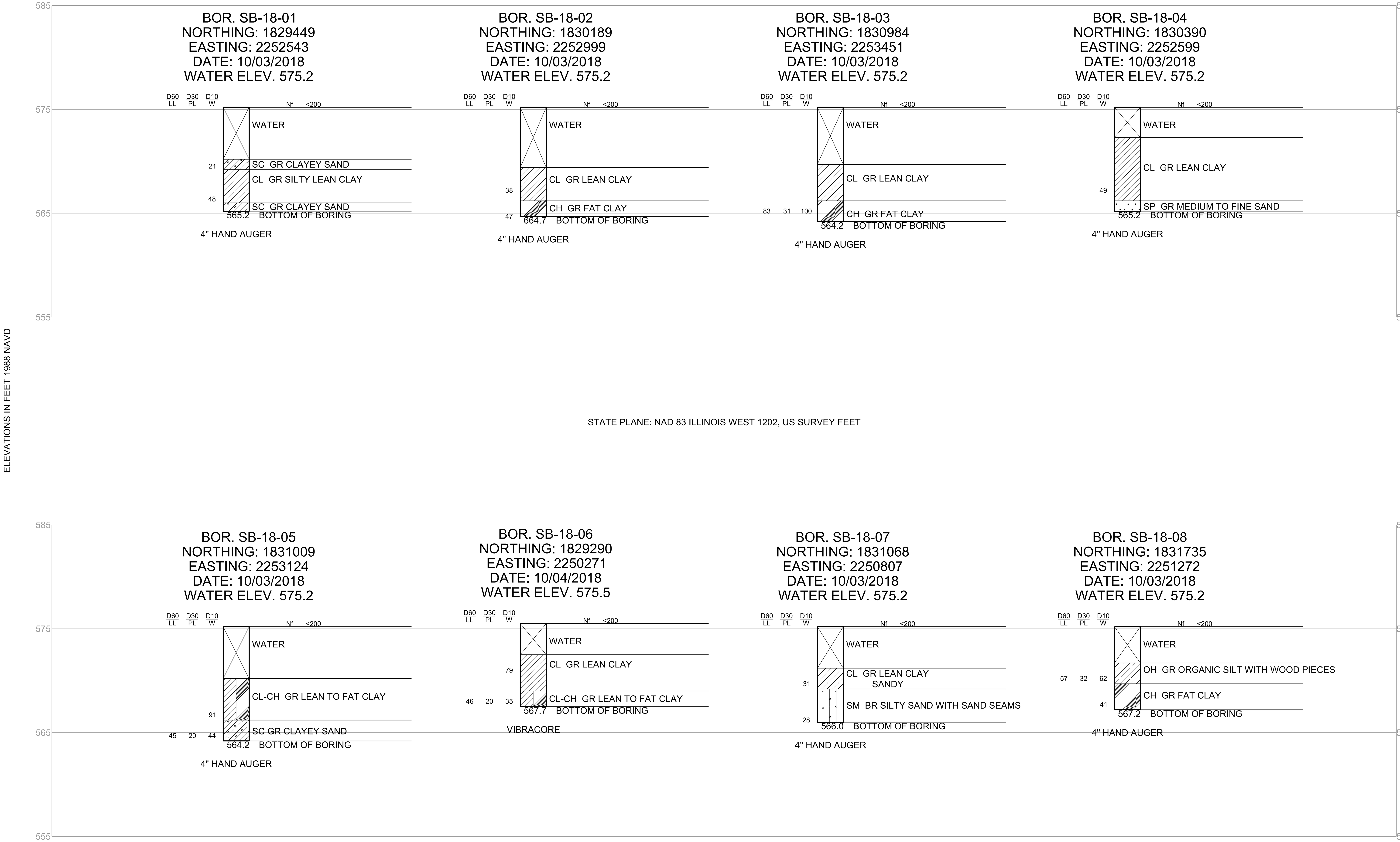

A1 BORING LOGS

SCALE : 1"=5'-0"

0 5' 10'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: | DWN BY: | CKD BY: | DATE: | SOLICITATION NO.: | SUBMITTED BY: | CONTRACT NO.: | PLOT SCALE: AS SHOWN | PLOT DATE: | PROJECT CODE: B5MRSI1801 | SIZE: ANSI D | FILE NAME: B5MRSI1801_B-601xxx.dgn

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
RIVER MILES 502.5 - 506.5
SCOTT COUNTY, IA
STEAMBOAT ISLAND HREP
FEASIBILITY REPORT
DIAGRAM
BORING LOGS

Sheet ID
B-601

REVIEW

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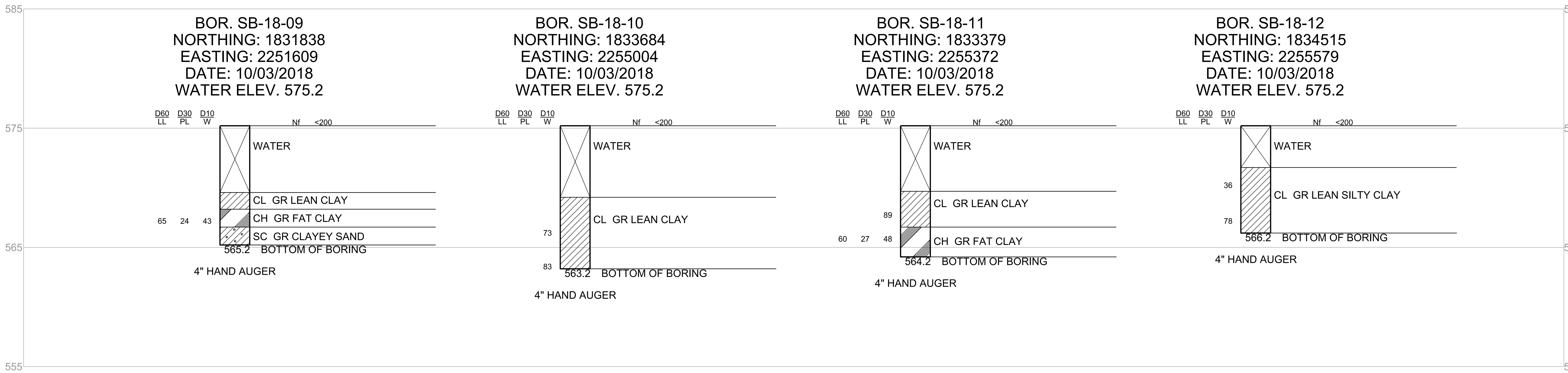
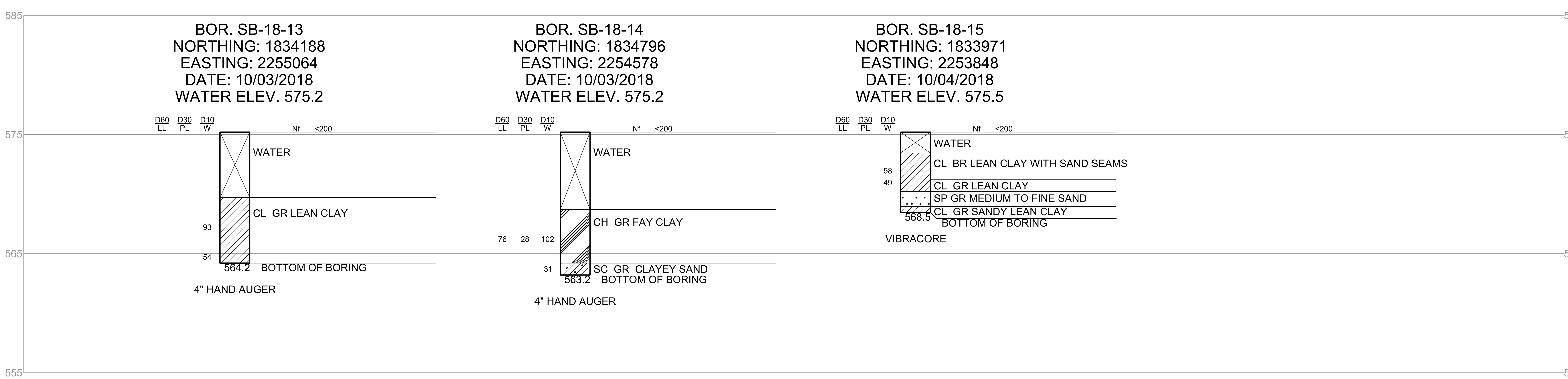
US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

ELEVATIONS IN FEET 1988 NAVD



STATE PLANE: NAD 83 ILLINOIS WEST 1202, US SURVEY FEET



A1 BORING LOGS

SCALE : 1"=5'-0"

0 5' 10'

DESIGNED BY: | DATE:
DWN BY: | CKD BY: | SOLICITATION NO.:
SUBMITTED BY: | CONTRACT NO.:
PLOT SCALE: AS SHOWN | PLOT DATE: | PROJECT CODE: B5MRSI1801
SIZE: ANSI D | FILE NAME: B5MRSI1801_B-602xxx.dgn

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
RIVER MILES 502.5 - 506.5
SCOTT COUNTY, IA
STEAMBOAT ISLAND HREP
FEASIBILITY REPORT
DIAGRAM
BORING LOGS

Sheet ID
B-602

REVIEW

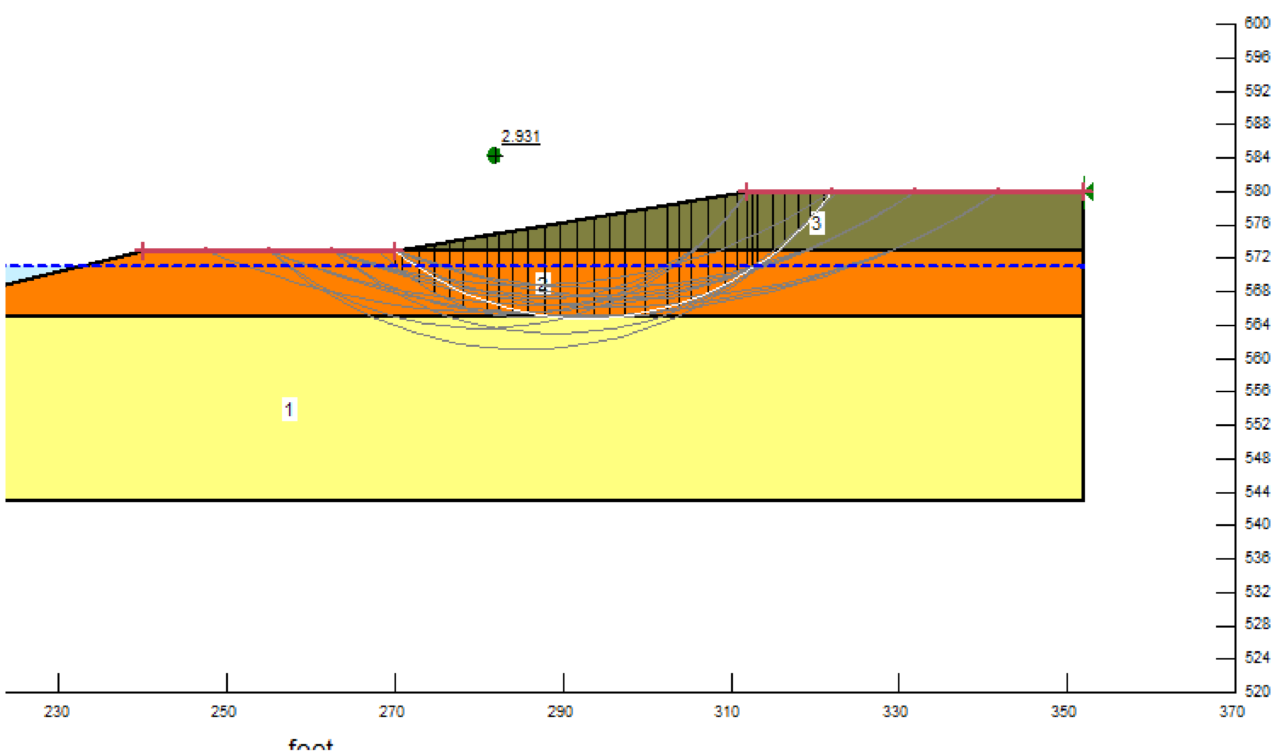
E:\lcs4pdf2\2023\312031_29\B5MRSI1801_B-602xxx.dgn
5/9/2019 9:49:23 AM
COE-MVRPWP02RCC$

APPENDIX G-B

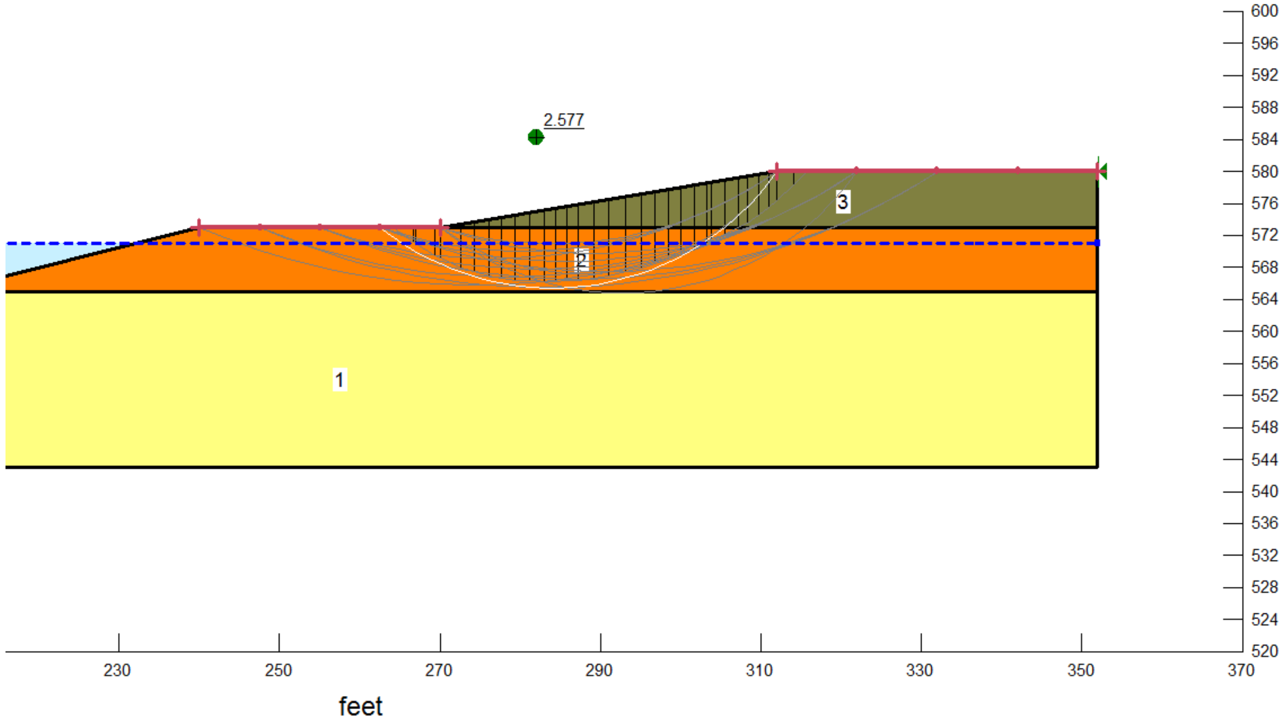
STABILITY ANALYSES

LEGEND

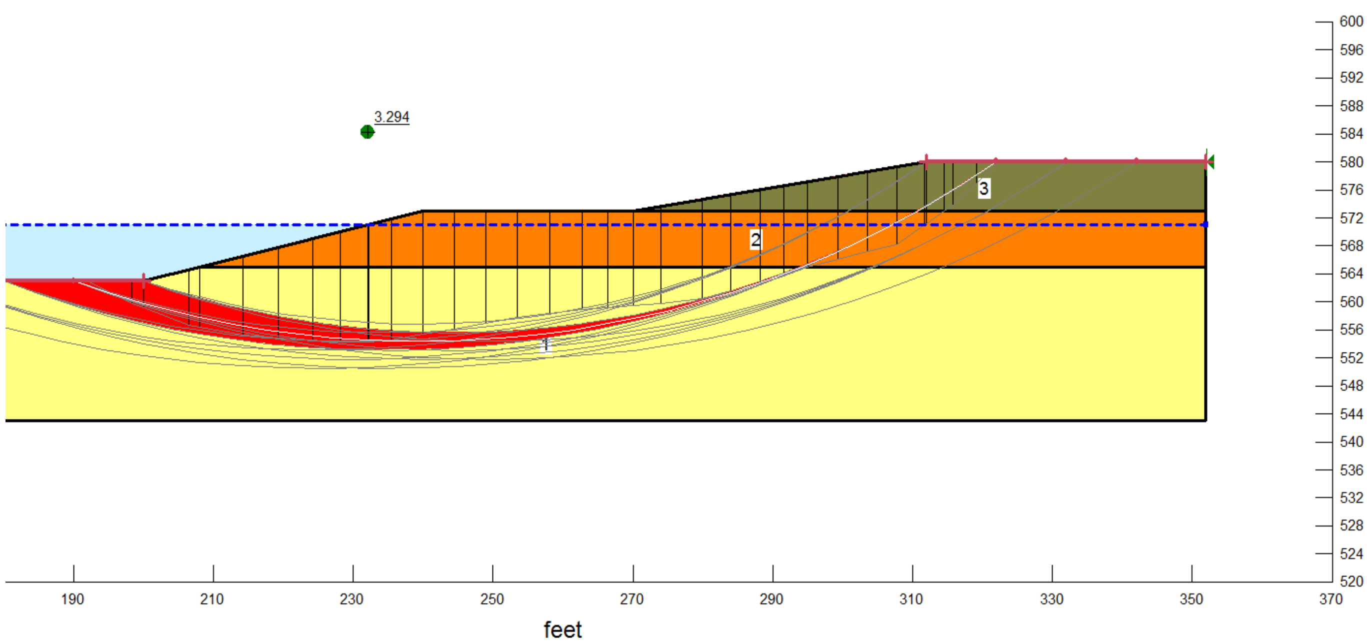
Material 1	**Sand**
Material 2	**Foundation**
Material 3	**Embankment**



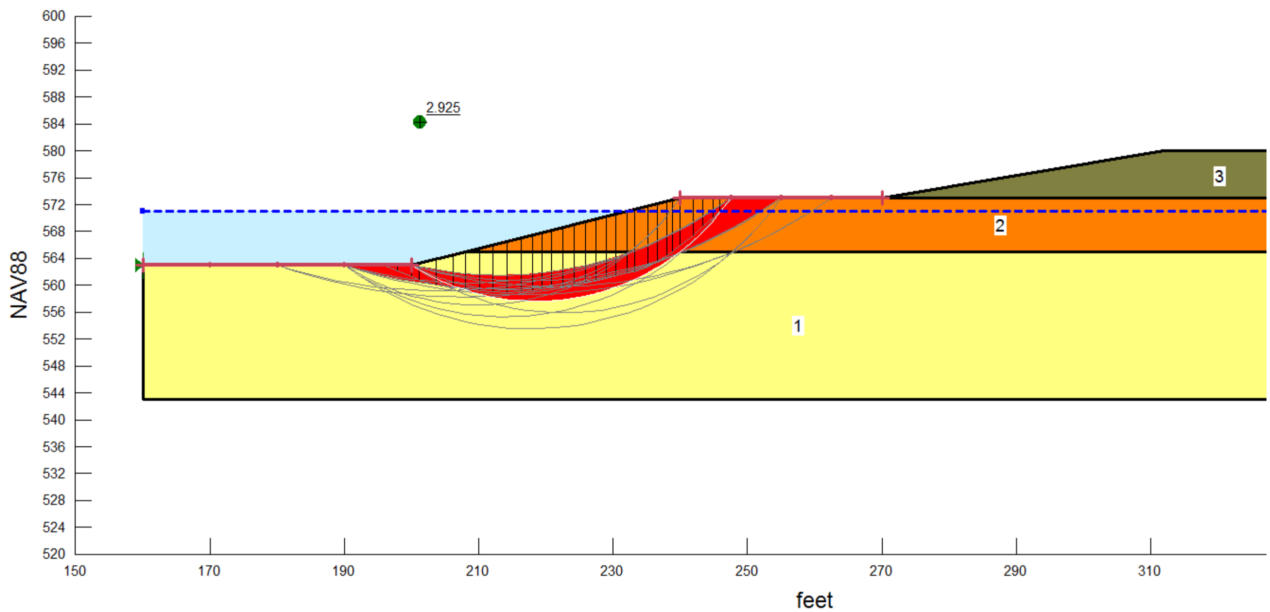
Embankment c=200 psf   Foundation c= 300 psf



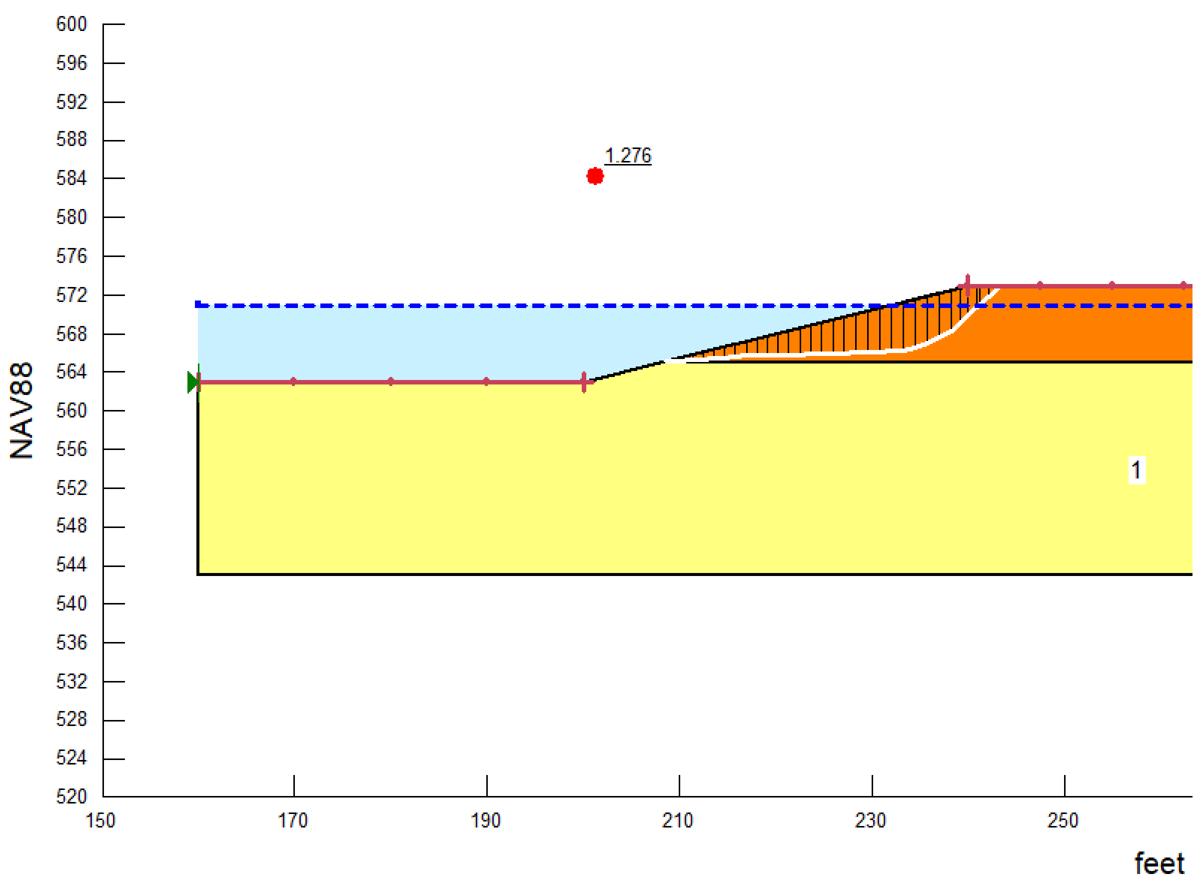
Embankment c=200 psf   Foundation ϕ= 19 degrees



Embankment c=200 psf   Foundation ϕ= 19 degrees



Embankment c=200 psf   Foundation c= 300 psf



Embankment c=200 psf   Foundation ϕ= 19 degrees

Slope Stability

File Information

- File Version: 8.16
- Title: Steamboat Island
- Created By: Kinney, Randall S MVR
- Last Edited By: Kinney, Randall S CIV USARMY CEMVR (US)
- Revision Number: 29
- Date: 6/13/2019
- Time: 9:35:50 AM
- Tool Version: 8.16.3.14580
- File Name: Steamboat Island.gsz
- Directory: P:\SLOPE STABILITY\GEO-SLOPE (from C drive Mar 29 2013)\GeoStudio2007\
- Last Solved Date: 6/13/2019
- Last Solved Time: 9:36:03 AM

Project Settings

- Length(L) Units: Feet
- Time(t) Units: Seconds
- Force(F) Units: Pounds
- Pressure(p) Units: psf
- Strength Units: psf
- Unit Weight of Water: 62.4 pcf
- View: 2D
- Element Thickness: 1

Analysis Settings

Slope Stability

- Kind: SLOPE/W
- Method: Spencer
- Settings
    - PWP Conditions Source: Piezometric Line
    - Apply Phreatic Correction: No
    - Use Staged Rapid Drawdown: No
- Slip Surface
    - Direction of movement: Right to Left
    - Use Passive Mode: No

Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: Yes
Critical Slip Surface Optimizations
Maximum Iterations: 2,000
Convergence Tolerance: 1e-007
Starting Points: 8
Ending Points: 16
Complete Passes per Insertion: 1
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.01
Minimum Slip Surface Depth: 3 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Sand

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Foundation

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Embankment

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 200 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (160, 563) ft
Left-Zone Right Coordinate: (200, 563) ft
Left-Zone Increment: 4
Right Projection: Range
Right-Zone Left Coordinate: (240, 573) ft
Right-Zone Right Coordinate: (270, 573) ft
Right-Zone Increment: 4
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (160, 563) ft
Right Coordinate: (352, 580) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	160	571
Coordinate 2	352	571

Points

	X (ft)	Y (ft)
Point 1	160	563
Point 2	200	563
Point 3	208	565

Point 4	240	573
Point 5	270	573
Point 6	312	580
Point 7	352	580
Point 8	352	573
Point 9	352	565
Point 10	160	543
Point 11	352	543

Regions

	Material	Points	Area (ft²)
Region 1	Sand	10,11,9,3,2,1	4,136
Region 2	Foundation	3,4,5,8,9	1,024
Region 3	Embankment	5,6,7,8	427

Current Slip Surface

Slip Surface: 126
F of S: 1.276
Volume: 96.585757 ft^3
Weight: 11,590.291 lbs
Resisting Moment: 711,625.2 lbs-ft
Activating Moment: 556,135.66 lbs-ft
Resisting Force: 2,040.1136 lbs
Activating Force: 1,602.5615 lbs
F of S Rank (Analysis): 1 of 126 slip surfaces
F of S Rank (Query): 1 of 126 slip surfaces
Exit: (208.65695, 565.16424) ft
Entry: (243.42115, 573) ft
Radius: 15.568852 ft
Center: (167.69369, 896.93473) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	209.22991	565.19104	362.47883	369.10151	2.2803715	0
Slice 2	210.56681	565.24064	359.38438	382.30094	7.8908044	0
Slice 3	211.88751	565.3092	355.10604	392.44568	12.857069	0
Slice 4	213.00101	565.40075	349.39295	397.25915	16.481655	0
Slice 5	214.11451	565.49231	343.67986	402.07263	20.106242	0
Slice 6	215.228	565.58387	337.96676	406.88609	23.730829	0
Slice 7	216.3415	565.67542	332.25367	411.69956	27.355415	0
Slice 8	217.45998	565.73633	328.45283	421.58502	32.067983	0
Slice 9	218.58345	565.7666	326.56426	434.02665	37.002268	0
Slice 10	219.70692	565.79686	324.67569	446.46829	41.936554	0
Slice 11	220.83039	565.82713	322.78712	458.90992	46.87084	0
Slice 12	221.95386	565.8574	320.89855	471.35156	51.805125	0
Slice 13	223.07733	565.88766	319.00998	483.79319	56.739411	0
Slice 14	224.2008	565.91793	317.12141	496.23483	61.673696	0
Slice 15	225.32427	565.94819	315.23284	508.67647	66.607982	0
Slice 16	226.44774	565.97846	313.34427	521.1181	71.542267	0
Slice 17	227.63329	566.02205	310.6243	531.74464	76.137838	0
Slice 18	228.88092	566.07896	307.07295	542.70195	81.133571	0
Slice 19	230.12855	566.13587	303.52159	553.65925	86.129304	0
Slice 20	231.37618	566.19278	299.97023	564.61655	91.125037	0
Slice 21	232.65534	566.25114	296.32914	585.94938	99.724246	0
Slice 22	233.92607	566.44988	283.92749	581.69143	102.52835	0
Slice 23	235.15685	566.78758	262.85501	576.8834	108.12865	0
Slice 24	236.37673	567.28171	232.02114	533.59004	103.8385	0
Slice 25	237.58571	567.93228	191.42588	491.94455	103.47688	0
Slice 26	238.64265	568.66063	145.97665	415.1288	92.676517	0
Slice 27	239.54755	569.46677	95.673447	349.28475	87.325375	0

Slice 28	240.44372	570.26513	45.855818	273.35021	78.332599	0
Slice 29	241.07537	570.83021	10.594896	211.31224	69.112524	0
Slice 30	241.71088	571.40435	-25.231596	153.86704	52.980672	0
Slice 31	242.60603	572.21306	-75.694788	75.884251	26.129043	0
Slice 32	243.23738	572.80871	-112.86319	17.911045	6.1672675	0